Survey and Nutritive Scanning of Low-cost Feedstuffs and Energy Requirement of Indian Major Carp, *Labeo Rohita* (Ham)

DISSERTATION

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF

Master of Philosophy

IN

ZOOLOGY

BY

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ALIGARH (INDIA)

1989

Phones : University : 285
Public : 5646

DEPARTMENT OF ZOOLOGY
ALIGARH MUSLIM UNIVERSITY
ALIGARH—202 002, U.P.
(INDIA)

Sections :
1. ENTOMOLOGY
2. PARASITOLOGY
3. ICHTHYOLOGY & FISHERIES
4. AGRICULTURAL NEMATOLOGY
5. GENETICS

Ref. No.

Date 8-11-1989

This is to certify that the dissertation entitled "Survey and Nutritive Scanning of Low-cost Feedstuffs and Energy Requirement of Indian Major Carp, Labeo rohita (Ham.) has been completed under my supervision by Md. Abul Hassan. This work is original and has been independently persued by the candidate.

I permit the candidate to submit the dissertation in partial fulfilment for the award of the degree of Master of Philosophy in Zoology of the Aligarh Muslim University, Aligarh.

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ACKNOWLEDGEMENTS

I am indebted beyond measure to Prof. A.K.Jafri, for his inspiration, constructive criticism and overall guidance during the course of the present study.

I offer my sincere thanks to the Chairman, Department of Zoology, Aligarh Muslim University, Aligarh,for providing the necessary laboratory facilities.

I am also indebted to Prof. John E. Halver, School of Fisheries, University of Washington, Seattle, USA, for his valuable suggestions and criticism.

All my colleagues, Messers Mukhtar A. Khan, M.F. Anwar, Erfanullah and Md. Nasiruddin,deserve thanks for their cooperation and help.

The financial assistance rendered by US Department of Agriculture is gratefully acknowledged.

GENERAL INTRODUCTION

The increasing demand for high quality low-cost animal protein has generated greater interest to develop and expand aquaculture all over the world. It is realised that scientific exploitation of cultivable water bodies can increase fish production manifold, and it has been predicted that, by the year 2000 AD, aquaculture could produce at least 50 million tons of animal protein, if proper research and development measures are undertaken (TAC, 1973) against a production of 10.5 million tons of fish and shellfish recorded through culture in 1983 (Pillay, 1986).

In India, until recently, extensive or traditional type of fish culture, with production as low as 1 ton/ha/yr or even less, was practiced by most fish farmers. Although low-density culture with minimum inputs and low production per unit area often proved more economical under certain situations than the intensive farming, involving the rearing of dense population and heavy inputs (Pillay, 1976), scientific culture practice and efficient management could lead to a substantial increase in fish production. Production rate as high as 10 tons/ha/yr has been achieved in static earthen freshwater carp culture ponds in India through optimum stocking, fertilization and supplementary feeding (Sinha, 1988).

Fish do require all the vital elements for their growth, reproduction, health and other normal physiological functions. A deficiency of one or more of the essential nutrients results in a reduced rate of performance, disease or even death. In different forms of aquaculture system, fish gather these nutrients from natural aquatic organisms or from the formulated feeds provided in the form of supplementary or whole feed. However, in the farming of these animals under controlled environment, unlike their natural habitat, feeding of the stocked population with nutritionally balanced and quality diets is of critical importance not only to promote their optimal biological and physiological functions but also to raise the production.

In intensive and semi-intensive fish culture systems, based on high stock density, feed is thus the major input, constituting 50-60% of the total operational expenditure. To minimise this input, it is almost essential to develop cost-effective and nutritionally adequate feed, using less expensive locally available ingredients (Pillay, 1986). Such ingredients generally include byproducts of grain/ oil industry, fish processing industries, meat processing industries, slaughter house wastes, droppings or wastes of poultry, duckery, dairy and piggery, etc. Several workers have attempted to scan such ingredients for their nutritive richness in order to incorporate these in low-cost fish diets (Morrison, 1961; Lakshmanan _et al._, 1967; Chakrabarty _et al._, 1973; Jhingran 1983, Ensminger and Olentine, Jr, 1980 and NAS-NRC, 1981, 1983).

Fish nutritionists in the past have generally given priority to quantifying the requirements for protein, minerals and vitamins (Halver, 1979; Cowey and Sargent, 1972, 1979; Castell, 1979; Lall, 1979; Nose and Arai, 1979; Ogino, 1979; Stickney, 1979; NAS-NRC, 1981, 1983; Jauncey, 1982; Watanabe, 1982; Ketola, 1982; Millikin, 1982; Takeuchi, _et al._, 1983; Cowey and Luquet, 1983; Lovell, 1984a; Robinson, 1984; Cho _et al._, 1985; Kanazawa, 1985; Halver, 1985; Watanabe, 1985; Wilson and Halver, 1986). Although levels and sources of energy in fish ration can significantly affect fish growth, relatively little information is available on the energy requirement of fish.

A factor considered equally important in the diet formulation is the estimation of fibre content. Although non-energy component of diet, the importance of fibre cannot be overlooked in nutritional studies. Chemically, it represents mixtures of cellulose, hemicellulose, lignin, pentosan and other generally undigestible fractions in the feed. Amongst many functions, it provides increased surface area of substrate to be acted upon by digestive juice, helps in uniform distribution of different nutrients, and facilitates in easy and smooth movement of food material through the alimentary canal, thereby helping in easy defacation and proper digestion. The level of fibre present in the diet has thus a direct role in digestion, absorption and growth efficiency of the animal. Several workers in the past have emphasized the importance of fibre inclusion in artificial fish feed (Dupree and Sneed, 1966; Leary and Lovell, 1975, Stickney and Shumway, 1974; Prejs and Blaszezyk, 1977; and Sumagaysay and Chiu, 1989). Feedstuffs of plant origin contain varied amounts of fibre. Inclusion of such feedstuffs in practical fish diet necessitates evaluation of their fibre content so as to avoid excessive levels of fibre in the diet, mainly because higher levels of fibre may inhibit feed intake, increase fecal waste production, and consequently pollute the water.

Data available on the proximate composition of feedstuffs reported earlier from this laboratory (Niamat, 1982) was neither based on guidelines of the International Network of Feed Information Centre

(INFIC) nor took into account level of fibre content in plant origin feedstuffs and chitin in silkworm pupae. Similarly, the energy values of the feedstuffs reported in the earlier study was based on conventional energy equivalents.

The work presented here was undertaken as part of a research program on the nutrition and diet development of cultivable finfish species. Since formulating rations for feedout or growth increment purposes generally entails consideration of availability, and the biochemical and nutritional features of the ingredients, the study included an assessment of the gross nutrient composition and energy density of locally available feedstuffs.

Besides, fibre has been quantified in the plant origin feedstuffs and chitin in the silkworm pupae. Unlike the earlier study, energy density in the feedstuffs was evaluated through direct combustion in a calorimeter. Additional information relating to the plant origin feedstuffs, as required by INFIC for retrieval purposes, have also been collected. These included details such as the season of harvest, method of preparation in the field, storage condition, types of soil in which grown, fertilizers used and type of farming, etc. The energy requirement for optimum growth was assessed in the Indian major carp, *Labeo rohita* (Ham). This is a fast growing, easily cultivable finfish species, and owing to its compatibility with other fish species, highly preferred for cultivation. Although the culture technology of Indian major carps has been perfected in may respects, assessment of nutritional needs of these fishes, leading to the development of complete artificial feed for their rearing, is an aspect which still remains to be precisely worked out to revolutionize the production.

The findings have been outlined under two separate chapters. Chapter I includes findings on the proximate composition and energy density of feedstuffs, Chapter II deals with the energy requirement of *L. rohita*.

CHAPTER - I

NUTRIENT COMPOSITION AND ENERGY DENSITY OF LOW-COST FEEDSTUFFS FOR THEIR POSSIBLE USE IN PRACTICAL FISH FEED

INTRODUCTION

With the intensification of fish culture operation in many countries of the world, including India, the search for suitable feedstuffs to develop nutritive and economical feed mixtures, based on less expensive locally available feed ingredients, is being increasingly felt (FAO/UNDP, 1979; Halver, 1982), since these contribute greatly to the commercial success of the culture operation. Research efforts are, therefore, directed towards scanning newer and/or economical feed ingredients for aquaculturally important fish species. Aquatic weeds, grasses and leaves have been tested for their suitability as fish feed ingredients (Hajra, 1987; Naskar and Sen. 1987; Pappathi and Paul Raj, 1987; Patra et al., 1989; Cagauan and Pullin, 1989; Naegel, 1989; Paul Raj, 1989; Halinge et al., 1989; Chiayvareesajja et al., 1989 and Klinnavee et al., 1989). Brans, polishing and oil cakes have been tested for their efficacy in practical fish diets (Wee and Little, 1989; Chattopadhyay and Konar, 1987;

Mohanty *et al.*, 1987; and Maria *et al.*, 1987). Agrobased waste products and livestock wastes also find use in the artificial feed for rearing different fish species (Nandesha *et al.*, 1988, and Toor *et al.*, 1988). Use of trash fish, blood meal, maggots and pupae of insects has also been attempted in artificial feed (Otubusin 1987; Nandesha *et al.*, 1989; and Abalos *et al.*, 1989). Efficacy, utilization and level of inclusion of different kinds of organic manure, biogass slurry and slaughter house offal in fish feed formulation were looked into by several workers (Kalyani and Shetty, 1987; Rao , 1987 ; and Haque, 1988). Growth studies on tilapia using single cell protein (*Spirulina*) has been made by Chow and Woo (1989). Recently, Bhuiyan *et al* (1989), keeping in view the intensity of aquaculture practice in Bangladesh, conducted an exhaustive survey to identify potential fish feed, based on their availability, price and primary nutritional value.

The present study reports the nutritive richness of locally available ingredients, screened for their proximate composition and energy density, which could find use in developing artificial fish feed.

MATERIALS AND METHODS

The feedstuffs collected from different sources were processed for assessment of their proximate composition and energy contents using standard techniques (AOAC, 1984). Five replicates were taken for each sample.

I. Estimation of water content

For the determination of moisture content each sample was thoroughly grinded to powder. Usually, 2-5 g of the powdered sample was taken in a pre-weighed vitreosil crucible and placed in an oven at 100°C for 20-22 hours. The crucible containing the dried sample was cooled to room temperature in a desiccator and reweighed to ensure that the sample had become completely dried, the entire process was repeated till a constant weight was obtained. The loss in weight gave an index of water from which the percentage of water was calculated. For fresh leafy ingredients the sample were first sun-dried, grinded to fine powder and preserved in polythene bags. This powder was then used for moisture estimation on dry weight basis.

II. Estimation of ash content

A known quantity (1-5 g) of powdered sample was taken in a pre-weighed vitreosil crucible, dried in an electric oven at 100°C and ignited in muffle furnace at 650°C till the sample became carbon-free and completely white. The crucible was cooled in a desiccator and reweighed to estimate the quantity of ash. The result was expressed as percentage on dry weight basis.

III. Estimation of crude fat

Crude fat in different feedstuffs was extracted with petroleum ether (B.P. 40-60°C) using the continuous soxhlet extraction technique. A weighed quantity (5 g) of finely powdered and oven dried (100°C) sample was taken in Whatman fat extraction thimble , plugged with cotton and introduced into the soxhlet. A clean dry receiver flask was weighed and fitted to the soxhlet. The extraction was carried out for about 10-12 hours. At the end of extraction, the solvent was recollected and the flask placed in an oven for few hours for complete removal of solvent traces. The flask was cooled in a desiccator and reweighed. The increase in weight of the flask gave the quantity of crude fat extracted from the known weight of the sample. The result was expressed as percent on dry weight basis.

IV. Estimation of crude protein

The estimation of crude protein in various samples was made by a slight modification of Wong's micro-kjeldahl method as adopted by Jafri *et al.* (1964). 0.1 g sample was digested in 5 ml of 1:1 sulphuric acid and heated till fumes disappeared. 0.5 ml saturated potassium persulphate was then added to oxidize the digesting mixture. The digestion was continued till the solution in the Kjeldahl flask became water clear, indicating that all the nitrogenous materials present in the sample has been converted into ammonium sulphate. The solution at this stage was transferred to volumetric flask and diluted to 50 ml. An aliquot (0.5 ml) of this solution was then directly nesslerized by adding Bock and Bendict Nessler's reagent (Oser, 1965). The solution was kept at room temperature for 10 minute for complete colour development and the intensity of colour read on Milton Ray splitbeam spectronic 1001 spectrophotometer at 480 mµ wave length. The intensity of colour developed was proportional to the amount of ammonium sulphate contained in the solution. The optical density obtained for the sample was read off against a standard calibration curve prepared by taking readings of a series of different dilutions containing known amount of nitrogen. This method gave a direct reading of the amount of total nitrogen present in the sample. The quantity of total nitrogen was multiplied with the conventional protein factor (6.25) to calculate the crude protein content. The values were calculated as percentage on dry weight basis.

V. Estimation of gross energy content

The estimation of gross energy in the feedstuffs was carried out through direct calorimetry. As a routine, five samples were tested for each ingredient. In order to ensure that the test sample is truely representative of the bulk of the sample material, standard sampling, grinding, mixing and subdividing procedures were followed. The sample was dried in hot air oven at 100°C for 24 hour. A weighed portion of the working sample was then taken into a metallic crucible and compacted carefully to reduce the rate of combustion. The combustion was carried out in a ballistic bomb calorimeter with appropriate corrections based on the standardization of the instrument with thermo-chemical grade benzoic acid as the standard. The gross energy (heat of combustion) was calculated as cal/g.

VI. Estimation of crude fibre

Crude fibre was determined as the fraction remaining after digestion with standard solution of sulphuric acid and sodium hydroxide under carefully controlled condition.

A weighed quantity (2 g) of dry fat-free sample was taken in a spoutless conical flask fitted with a reflect condenser. Boiling water was added to it followed by addition of 25 ml sulphuric acid (10%). The content was mixed, the volume raised to 200 ml and boiled for 30 minutes. Acid solution was removed and the filtrate collected. The residue was then washed at least three times with boiling water. To this, was added 25 ml sodium hydroxide (10%) solution and the content diluted to the mark. It was boiled for another 30 minute. At the end of the boiling, filtering and washing were repeated. The resulting residue was transferred to a porcelain crucible, dehydrated using ethanol and dried to a constant weight at 100°C. This was incinerated for 2 hours in a muffle furnace at 650°C. The fibre content was calculated on the basis of difference in weight of the residue after drying and ignition, the value (on moisture free basis) was expressed as per cent by weight.

VII. Estimation of chitin

Dried, powdered and weighed (2 g) sample was taken in a centrifuge tube. Sodium hydroxide (10%) solution was added to it, and the tube kept in a thermostat maintained at 60°C for 24 hours. It was then centrifuged at 4000 rpm for 15 minutes. The supernatant soluble protein was discarded and the residue dried to a constant weight. The chitin content was calculated on the basis of difference between initial and final weights, and expressed as per cent by weight.

RESULTS

Data on proximate composition and gross energy content of the feedstuffs have been given in Tables I-VI. Of the feedstuffs of plant origin, soybean oil cake (*Glycine max*) contained the maximum (51%) crude protein content. This was followed by groundnut oil cake (*Arachis hypogea*), with 47% crude protein. The protein in other oil cakes ranged between 33 to 40%. Among the husks, brans and dusts, lentil dust (Lens culinaris) showed the maximum (30.7%) crude protein, followed by wheat bran (Triticum aestivum) with 15.8%, and pigeon pea dust (Cajanus cajan) with 14% crude protein. The protein values in other plant products, ranged between 4-10%. Among the other products, blood meal and sardine fish meal showed higher values of crude protein, amounting to 74% and 53%, respectively. Dried, silk worm pupae (Bombyx mori) and mantis shrimp (Squilla sp.) meal contained low protein, 40.6% and 33%, respectively. With the exception of soybean oil cake, the different oil cakes examined contained crude fat in the range of 6-10%.

The lowest value of fat observed in soybean oil cake could be ascribed to the use of solvent extraction procedure followed by the oil mill. Rice polish (Oryza sativa) contained 11.6% fat, whereas barley dust (Hordeum vulgare) and Bengal gram husk (Cicer arietinum) showed low values, 0.6% and 0.5%, respectively. The crude fat content in other products was in the range of 1.5 to 4.9%. In the animal by-products, the crude fat was maximum (21.7%) in silk worm pupae, followed by sardine fish meal (11.5%). The fat level in mantis shrimp meal and blood meal was low (1.8%) and comparable.

The moisture content in various feedstuffs ranged from 2.6 to 11.6%. The total ash content was highest (14.4%) in rice bran, followed by mantis shrimp meal (12.2%). The lowest (3.6%) ash was noted in barley dust. In the remaining feedstuffs, the ash content ranged between 4.3 and 10.5%.

Crude fibre content among the feedstuffs of plant origin was found to be the highest (42.3%) in Bengal gram husk. This was followed by cottonseed oil cake (*Gossypium sativum*) and pigeon pea dust with 28.4% and 25.7% crude fibre, respectively. Sesame oil cake (*Sesamum indicum*) contained 15.4% crude fibre, which is comparable to chitin content of silk worm pupae (13.2%). In other feedstuffs, the crude fibre content ranged between 7 and 11%.

The gross energy content of various ingredient studied depicted a wide range of energy density with the minimum (2962 cal/g) in mantis shrimp meal and maximum (5670 cal/g) in dried silk worm pupae. Sardine fish meal and slaughter-house waste contained more than 5000 cal/g of gross energy. Rice bran, pigeon pea husk, black gram husk and tapioca flour showed less than 4000 cal/g of gross energy. The oil cakes analysed, showed average values, ranging from 4492 to 4850 cal/g of gross energy. Wheat bran had a comparable energy value with the oil cakes. Barley husk and Bengal gram husk showed similar values (4037 cal/g and 4036 cal/g). Rice polish and barseem showed a close range of energy density, comparable to different oil cakes.

Tables(VII-XVIII)contained additional information on the plant origin feedstuffs required for the INFIC retrieval system.

DISCUSSION

Although the usefulness of several artificial feedstuffs of plant and animal origin have been indicated for the spawn, fry and fingerlings of Indian major carps (Chakarborty *et al.*, 1973; Jhingran, 1983; Mohanty *et al.*, 1987; and Chattopadhyay and Konar, 1987) and the catfish (Venkatesh *et al.*, 1986 and Niamat, 1982; and Niamat and Jafri 1984 a,b,)dietary formulations for these and other Indian cultivable fishes generally included combinations of a few conventional feedstuffs, mainly for supplementary feeding. Despite the wide variety of animal and plant origin feedstuffs, that are available at cheaper cost and that could possibly be incorporated in fish rations, very few have been nutritionally evaluated for the above purpose. The use of locally available less expensive feed ingredients for carp polyculture in India has been stressed earlier in FAO technical report (Chow, 1982).

Since protein is by far the most important and often the most expensive dietary nutrient component required for growth, newer and cheaper protein sources, particularly those which do not compete as feed for other animals, are being scanned for use in fish feeds. Most fish species, depending upon their physiological needs, are generally known to require 20-60% crude protein in their diet (Hastings, 1979). The gross nutrient analysis of various feedstuffs carried out during the present study reveals the nutritive richness of a number of feedstuffs in terms of protein and other nutrients, and indicates to the feasibility of incorporating these low-cost ingredients in practical diets of our traditionally cultured fish species. It also points to the possibility where one ingredient could be replaced by the other. The use of conventional feed ingredients and a new generation of non-conventional products (SCP, plant protein concentrates, animal food processing wastes, etc.) as protein sources in complete diets for fish has been attempted by several workers in the past on various fish species (Tacon and Jackson, 1985; and Chow and Woo, 1989). Several of these attempts were directed to replace the fish meal portion of the diet (Cho et al., 1974; Spinellie et al., 1979; Viola et al., 1982;and Hilton, 1983), a commodity becoming expensive year after year with supplies not too dependable either. The analysis of various locally available feedstuffs indicate that byproducts like blood meal, fish meal, soybean meal, groundnut oil cake, containing over 45% crude protein, could be incorporated in high protein fish feeds. On the other hand, feedstuffs such as cottonseed meal, mustard oil cake, rocket salad oil cake, sesame oil cake, lentil dust and silkworm pupae could be utilised in formulating average protein diets.

In India and many of the south-east asian countries, where paddy is extensively cultivated, byproducts of rice mill, like rice polish and rice bran, are conventionally used in various combinations with different oil cakes as supplementary feed for carps and other fishes. The use of rice bran and low quality trash fish has been recommended in different rations as feed for certain species of freshwater catfish (Dehadrai and Thakur, 1980).

In formulating practical diets with desired level of protein, care must also be taken to consider optimum level of energy (NAS-NRC 1983), so that the fish can make full utilization of available protein for their growth purposes. Ingredients like silkworm pupae, slaughter-house offal, fish meal, algal meal, certain oil cakes and brans can conveniently be used for the maintenance of energy level.

The fibre component of different feedstuffs can be useful in obtaining a proper nutrient balance as well as adequate water stability in the feed. Ingredients like cottonseed oil cake, sesame oil cake, pigeon pea dust, Bengal gram husk, silkworm pupae, with higher values of fibre/chitin, can be utilized for the above purpose.

It has been emphasized that in order to utilize protein efficiently for growth, other sources of energy such as fat and carbohydrate must also be present in fish diet (Halver, 1976; and Wilson and Halver, 1986). Since most fish have the ability to use fat and carbohydrate, to some extent, to spare protein as an energy source (Ringrose, 1971; Lee and Putnam, 1973; Takeuchi et al., 1978 a,b,c; Pieper and Pfeffer, 1979; Bergot, 1979 a,b. Takeuchi et al., 1979 ; Shimeno et al., 1980; Bromley 1980; Yu and Sinnhuber, 1981; Gatlin and Stickney, 1982, NAS-NRC, 1983; Stickney, 1984; and Strange, 1984), the inclusion of these nutrients are considered especially useful in developing feeds for young fish where protein needs for growth are the maximum (Hastings and Dupree, 1969; Mertz, 1972; Halver, 1976; and Wilson and Halver, 1986). As far as the requirement of fat for carp and catfish are concerned, it is reported to be 6-16% of the diet (Watanabe, 1982; and Stickney, 1984). Fats, being high energy nutrient, are known to be 85-90% digestible (Takeuchi et al., 1979; Austreng et al., 1980; NAS-NRC, 1981; Cho et al., 1985; Law, 1986; and Kirchgessner et al., 1986). Thus, besides fish meal, fat rich ingredients like mustard oil cake, rocket salad oil cake, sesame oil cake, rice polish and silkworm pupae could also be considered for inclusion in fish feeds at various levels.

The carbohydrate component of diet, besides providing energy, texturises the feed, acting as binder in case of expanded and compressed pellets. Ingredients like rice polish and tapioca flour appear to be of practical utility in this regard.

The result of the evaluation of gross energy content of locally available feedstuffs points to the nutritive richness of a good number of such ingredients. Some of the low-cost products like oil cakes, brans and husks, slaughter-house waste and silkworm pupae appeared exceedingly rich in calories.

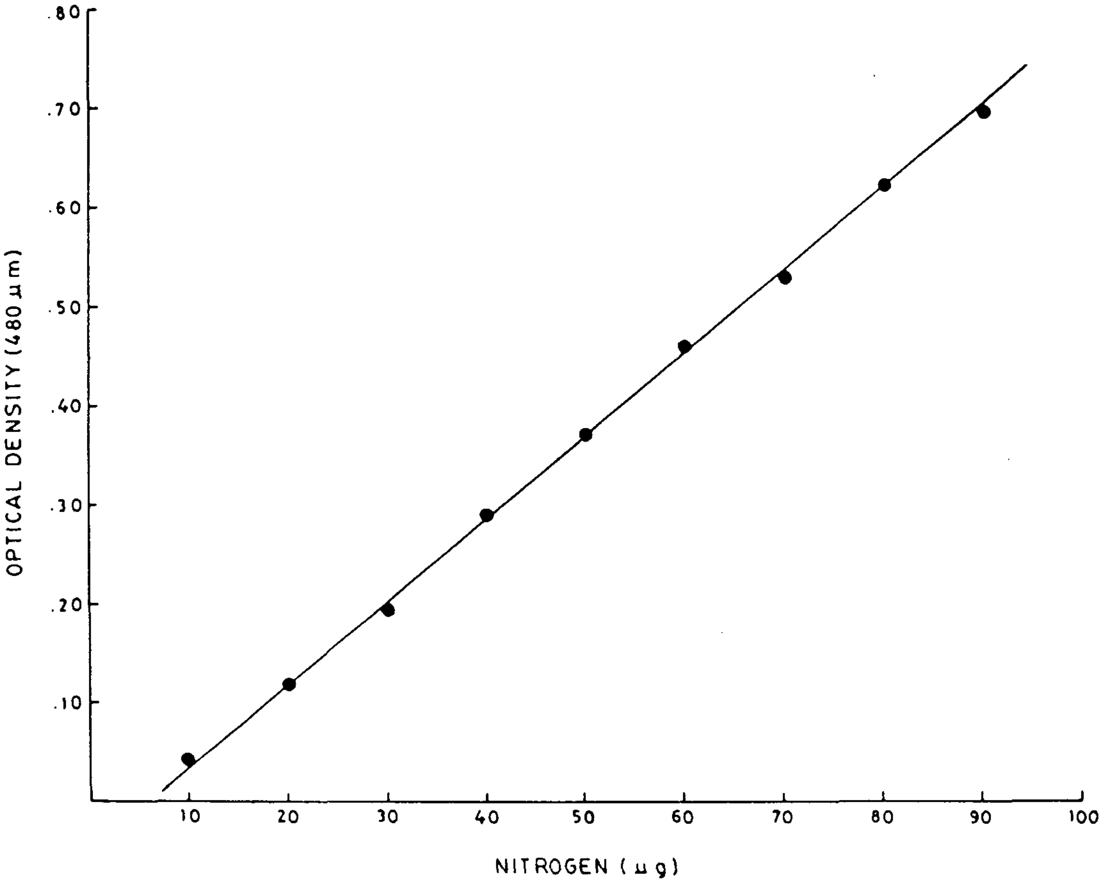
The values obtained during the present study on the proximate composition and energy density of feedstuff were found generally comparable to those reported elsewhere (Ensminger and Olentine, 1980; and NAS-NRC; 1981, 1983).

It may, however, be pointed out that although many of the feedstuffs, scanned for their nutrient and energy content, could be useful in developing rations for cultivable fish species, the levels of inclusion of these ingredients must be determined keeping in view the nutritional requirements of the concerned species and also factors like the chemical characteristics, food value, digestibility, availability and overall cost of the feedstuffs.

SUMMARY

The survey of feedstuffs indicate that a great range of cheaper feedstuffs, both of plant and animal origin, are locally available. There being a greater variety of agricultural products that are cheaply and adequately available and their inclusion in fish diet could contribute to its cost-effectiveness. Analysis of nutritional qualities, based on proximate composition and calorific value, of these

locally available feedstuffs points to their nutritive richness. Several of the ingredients analysed were rich in their protein and gross energy contents. Some of the less expensive ingredients rich in protein could partly supplement the expensive or conventional protein sources in formulated feeds. Practical and economical rations can thus be formulated for cultivable fish species making greater use of locally available feedstuffs.



Calibration Curve of Nitrogen

Table I : Proximate composition of feedstuffs (g/100g, as fed basis)

	Moisture	Crude Protein	Crude Fat	Ash	Crude Fibre
<u>Oil cakes</u>					
1. Mustard oil cake (<u>Brassica nigra</u>)	[1] 6.70 ± 0.08 [2] 6.50–7.05 [3] (6)	35.91 ± 1.00 31.44––39.10 (8)	9.63 ± 0.79 6.95 – 12.56 (6)	8.25 ± 0.09 8.05 – 8.65 (7)	10.45 ± 0.22 9.70 –10.94 (5)
2. Mustard oil cake (<u>Brassica compestris</u>)	2.64 ± 0.14 2.35–3.20 (6)	37.94 ± 1.17 33.70 – 42.46 (8)	9.82 ± 0.12 9.30 – 10.09 (6)	7.79 ± 0.04 7.70 – 7.95 (6)	9.26 ± 0.20 8.50 – 9.70 (5)
3. Cotton seed oil cake (<u>Gossypium sativum</u>)	8.06 ± 0.08 7.85–8.40 (6)	32.88 ± 1.27 29.56 – 37.50 (6)	5.65 ± 0.68 3.84 – 7.10 (5)	4.82 ± 0.21 4.45 – 5.50 (5)	28.35 ± 0.31 27.80 – 28.92 (4)
4. Rocket salad oil cake (<u>Eruca sativa</u>)	5.89 ± 0.35 4.64–6.85 (6)	40.61 ± 1.46 35.60 – 46.75 (8)	7.98 ± 0.42 7.04 – 9.55 (6)	8.01 ± 0.19 7.50 – 8.50 (6)	9.63 ± 0.28 9.21 – 10.45 (4)
5. Soybean oil cake (solv.extd) (<u>Glycine max</u>)	7.05 ± 0.46 5.80–8.55 (6)	51.05 ± 2.09 45.64 – 62.24 (8)	0.67 ± 0.16 0.20 – 1.36 (8)	7.13 ± 0.12 6.70 – 7.60 (6)	8.52 ± 0.17 8.20 – 9.10 (5)
6. Groundnut oil cake (<u>Arachis hypogea</u>)	6.34 ± 0.15 5.80–6.90 (6)	47.41 ± 1.15 43.42 –53.26 (8)	5.76 ± 0.95 3.14 – 8.05 (6)	6.75 ± 0.43 5.60 – 7.65 (4)	8.29 ± 0.27 7.75 – 9.04 (4)
7. Sesame oil cake (<u>Sesamum indicum</u>)	2.88 ± 0.05 2.73–3.10 (6)	34.22 ± 0.97 29.02 – 37.54 (8)	6.72 ± 0.21 6.15 – 7.45 (6)	10.50 ± 0.14 10.15 – 11.00 (5)	15.43 ± 0.25 14.70 – 16.20 (5)

[1] ± SEM ; [2] Range ; [3] Number of samples analysed.

Table II : Proximate composition of feedstuffs (g/100 g, as fed basis)

Brans/Husk/Dust	Moisture	Crude Protein	Crude Fat	Ash	Crude Fibre
1. Pigeon pea dust (*Cajanus cajan*)	[1] 8.20 ± 0.41 [2] 7.05 – 9.15 [3] (6)	13.96 ± 0.43 12.09 – 15.66 (8)	2.43 ± 0.37 0.70 – 3.49 (7)	5.43 ± 0.05 5.25 – 5.60 (6)	25.72 ± 0.28 25.16 – 26.50 (4)
2. Bengal gram husk (*Cicer arietinum*)	11.60 ± 0.26 10.50 –12.15 (6)	4.28 ± 0.59 3.10 – 5.72 (4)	0.48 ± 0.15 0.18 – 0.65 (3)	4.28 ± 0.06 4.15 – 4.50 (5)	42.29 ± 0.21 41.70 – 42.69 (4)
3. Bengal gram dust (*Cicer arietinum*)	9.70 ± 0.45 8.40 – 11.00 (6)	9.58 ± 0.70 7.11 –11.72 (8)	2.48 ± 0.21 1.70 – 3.10 (6)	4.26 ± 0.10 4.05 – 4.60 (5)	-
4. Lentil dust (*lens culinaris*)	8.02 ± 0.34 6.68 – 8.80 (6)	30.69 ± 0.92 27.06 – 34.26 (8)	1.49 ± 0.26 0.61 – 2.01 (5)	5.41 ± 0.07 5.15 – 5.65 (6)	7.11 ± 0.15 6.80 – 7.50 (5)
5. Barley dust (*Hordeum vulgare*)	10.11 ± 0.09 9.80 – 10.50 (6)	7.91 ± 0.22 7.20 – 8.96 (8)	0.61 ± 0.20 0.29 – 1.34 (5)	3.57 ± 0.13 3.15 – 4.00 (5)	8.60 ± 0.43 7.20 – 9.57 (5)
6. Wheat bran (*Triticum aestivum*)	10.86 ± 0.71 8.05 – 12.55 (6)	15.82 ± 0.41 14.20 – 17.33 (8)	4.89 ± 0.10 4.65 – 5.15 (5)	6.19 ± 0.08 5.95 – 6.50 (6)	10.26 ± 0.20 9.52 –10.70 (5)
7. Rice polish (*Oryza sativa*)	9.06 ± 0.14 8.70 – 9.50 (5)	9.90 ± 0.49 8.25 – 11.30 (5)	11.57 ± 0.52 10.20 – 12.67 (4)	5.18 ± 0.17 4.90 – 5.90 (5)	-
8. Rice bran (*Oryza sativa*)	3.26 ± 0.17 2.80 – 3.80 (5)	5.87 ± 0.46 4.90 – 7.50 (5)	1.84 ± 0.12 1.57 – 2.10 (4)	14.40 ± 0.35 13.50 – 15.00 (4)	-

[1] ± SEM ; [2] Range ; [3] Number of samples analysed

Table III : Proximate composition of feedstuffs (g/100 g, as fed basis)

	Moisture	Crude Protein	Crude Fat	Ash	Crude Fibre
Miscellaneous					
1. Sardine fish meal (*Sardinella* sp.)	[1] 6.52 ± 0.30	53.07 ± 1.32	11.48 ± 0.31	7.08 ± 0.14	
	[2] 5.60 – 7.20	48.93 – 58.39	10.50 – 12.30	6.60 – 7.35	–
	[3] (5)	(7)	(5)	(5)	
2. Blood meal	7.82 ± 0.32	74.37 ± 1.47	1.76 ± 0.17	6.42 ± 0.14	
	6.80 – 8.70	70.00 – 78.90	1.30 – 2.10	6.00 – 6.85	–
	(5)	(6)	(4)	(5)	
3. Mantis shrimp meal (*Squilla* sp)	5.20 ± 0.29	33.18 ± 1.82	1.81 ± 0.19	12.21 ± 0.19	
	4.70 – 5.70	29.90 – 38.20	1.30 – 2.20	11.85 – 12.50	–
	(3)	(4)	(4)	(3)	
4. Silkworm Pupae (*Bombyx mori*)	2.52 ± 0.18	40.69 ± 1.24	21.73 ± 0.29	4.20 ± 0.12	13.23 ± 0.20
	2.21 – 2.63	38.11 – 41.01	20.89 – 22.33	3.82 – 4.78	12.32 – 14.29

[1] ± SEM ; [2] Range ; [3] Number of samples analysed

Table IV : Gross Energy content of the feedstuffs

Feedstuffs	Gross Energy (cal/g)
Oil Cakes	
1. Mustard oil cake (*Brassica nigra*)	4748.5 ± 69.51 (4501.0 - 4894.0)
2. Mustard oil cake (*Brassica campestris*)	4850.2 ± 27.67 (4763.0 - 4938.0)
3. Cottonseed oil cake (*Gossypium sativum*)	4719.0 ± 19.67 (4675.0 - 4763.0)
4. Rocket salad oil cake (*Eruca sativa*)	4492.0 ± 37.66 (4413.0 - 4632.0)
5. Soybean oil cake (*Glycine max*)	4559.4 ± 8.48 (4544.0 - 4588.0)
6. Groundnut oil cake (*Arachis hypogea*)	4657.8 ± 22.22 (4588.0 - 4719.0)
7. Sesame oil cake (*Sesamum indicum*)	4596.8 ± 59.39 (4544.0 - 4807.0)

± SEM of 5 samples

Values in parentheses indicate the range

Table V : Gross Energy content of the feedstuffs

Feedstuffs	Gross Energy (cal/g)
Brans/Husk/Dust	
1. Rice bran (*Oryza sativa*)	3502.2 ± 21.69 (3452.0 - 3583.0)
2. Wheat bran (*Triticum aestivum*)	4518.2 ± 35.55 (4413.0 - 4632.0)
3. Pigeon pea husk (*Cajanus cajan*)	3800.5 ± 24.22 (3730. - 3899.0)
4. Lentil husk (*Lens culinaris*)	4360.8 ± 25.45 (4282.0 - 4413.0)
5. Lentil dust (*Lens culinaris*)	4334.8 ± 25.65 (4238.0 - 4370.0)
6. Pigeon pea dust (*Cajanus cajan*)	4299.4 ± 50.94 (4151.0 - 4413.0)
7. Barley husk (*Hordeum vulgare*)	4036.0 ± 29.75 (3933.0 - 4107.0)
8. Bengal gram husk (*Cicer arietinum*)	4037.4 ± 22.27 (3976.0 - 4107.0)
9. Black gram husk (*Phaseolus mungo*)	3810.2 ± 25.45 (3758.0 - 3889.0)

± SEM of 5 samples

Values in parentheses indicate the range

Table VI : Gross Energy content of the feedstuffs

Feedstuffs	Gross Energy (cal/g)
Miscellaneous	
1. Sardine fish meal (*Sardinella* sp.)	5216.2 ± 55.93 (5037.0 – 5377.0)
2. Mantis shrimp meal (*Squilla* sp.)	2962.4 ± 21.42 (2884.0 – 3015.0)
3. Slaughterhouse waste(offal)	5366.3 ± 85.86 (5025.5 – 5462.5)
4. Silkworm pupae *Bombyx mori*	5670.0 ± 39.78 5381.2 – 5810.7
5. Algal meal (*Spirulina* sp.)	4850.7 ± 110.85 (4544.8 – 5069.2)
6. Tapioca flour (*Manihot utilissima*)	3915.5 ± 32.78 (3845.6 – 4020.4)
7. Rice polish (*Oryza staiva*)	4579.6 ± 15.34 (4550.0 – 4630.0)
9. Barseem (*Trifolium alexandrium*)	4559.36 ± 29.24

± SEM of 5 samples

values in parentheses indicate the range

Table -VII

International Source Form for Composition of Feeds

(Please print) Card 10

Project No. 645 Experiment No. FSA-1 Leader Prof.A.K.Jafri 12 17

Laboratory name Fish Nutrition Research Laboratory 22

Address Department of Zoology,
Aligarh Muslim University, Aligarh, India

Do not write in shaded areas.

Laboratory director

For Code

Laboratory sample No. 1 24

Origin and Name of Sample

Date originally collected Month March Day Monday Year 1987 30

Country India 36

Region Northern India Altitude (meters) 184 39 42

State, province or department U.P. 46

County or district Aligarh 48

Literature reference ICAR-Handbook of Agriculture 51

Class: Dry forage (cut and cured) | Pasture (including range plants) | Cut and fed green | Silage

Scientific name: Genus Glycine

Species max

Variety or kind Type - Verde, Bansai,

Common name of feed Geri kalai

International Feed Reference No 58

Part of plant, animal or feed product Beans

Process undergone before fed to animal

Stage of maturity 75 - 110 days Card 20

Cutting or crop 1 Height when cut (centimeters) 0180 12

Official grade or No. 16 20 24

Fertilizer: kg per hectare N ---- P ---- K ----

Days between last application and harvest 28

Purity % Chief contaminant

Soil classification Field classification Alluvium 31

Surface texture Sandy 34

Digestibility Trial

Animal: Kind Fish (Labeo rohita) Card 30 12

Breed Sex 15 18 19

Age: Years 0 + Months Weeks 21

Number of animals in treatment 10 26

Total number of determinations per feed per animal 2 period No. 28 29

Average weight of animals, kg or g 24.7 30

Physiological state: non-pregnant | pregnant 1st 2/3 | pregnant last 1/3 36

losing wt | maintaining wt | gaining wt | fattening 37

very thin | thin | thrifty | fat | very fat 39

Percent of test ingredient in ration fed (100.0% dry matter) 40

Ad Libitum feeding ✓ Controlled feeding 42

Feed fed alone ✓ Feed not fed alone, digestion by difference 43

Method: Total feces collection | feces indicator ✓ 44

Physical form of feed Moist cake. 45

Basis for calculating level of feeding: NE ME DE TDN 48

Length of trial: Preliminary days 03 Collection days 03 49 51

Daily dry matter consumed g kg 53

Daily dry matter offered g kg 59

Daily orts or weighback g kg 65

Temperature: Degrees C (indicate if negative) 026 71

Pressure: millimeters 74

Humidity: percent 78

Card 40

Dry Matter

		Dry Matter %	Method of analyses, if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff %
Dry matter of sample on as fed basis	101	92.9	Above 105° C or in vacuum		

Dry Matter Basis on Which Analytical Data are Reported on This Form

Basis	Check one only		Fill in one only
As fed	✓	102	
Partially dry		103	
Dry (100 0% dry matter)		104	

NOTE: All analytical data on this sheet, except dry matter, must be expressed as indicated i.e.: as fed, partially dry, dry (100 0% dry matter). Where analytical data for one feed is partly on one basis and partly on another use separate sheet for each basis or convert to same basis.

Proximate Principles

		%	Method of analyses, if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff %
Ash	105	07.1	Assoc Official Agr Chem 1960		
Crude fiber	106	08.5	Weerde		
Ether extract	107	00.6	Assoc Official Agr Chem 1960		
Nitrogen-free extract	108	25.5	By difference		
Protein	109	51.0	Kjeldahl		
Nitrogen	212		do		
Nitrogen factor	213	6.25	Write in factor to convert to protein		

Energy

		kcal per kg			
Gross energy	421	4559	Bomb calorimeter		
Digestible	422	0079	Harris Natl. Acad Sci Natl Res Council pub. 1411 1965		
Metabolizable	423		do		
N-equilibrium metabolizable	424		do		
NE_m	426		Lofgreen J Animal Sci 27:793 1968		
NE_{gain}	427		do		
$NE_{lactating\ cows}$	430		Moe J Dairy Sci 52:928		
		%			
TDN	429		Biological		

Feed Information Center
Food and Agriculture Organization of the United Nations (FAO, AGA)
Via delle Terme di Caracalla
00100 Rome, Italy

Mail duplicate to

Read instructions before filling in form.

Table - VIII

International Source Form for Composition of Feeds

(Please print) Card 10

Project No. 645 **Experiment No** FSA-1 **Leader** Prof. A.K.Jafri 12 17 22

Laboratory name Fish Nutrition Research Laboratory

Address Department of Zoology,
Aligarh Muslim University, Aligarh, India

Do not write in shaded areas.

Laboratory director

For Code

Laboratory sample No. 2 24

Origin and Name of Sample

Date originally collected	Month March Day Monday Year 1987 30
Country	India 36
Region	Northern India Altitude (meters) 184 39 42
State, province or department	U.P. 46
County or district	Aligarh 48
Literature reference	ICAR-Handbook of Agriculture 51

Class	Dry forage (cut and cured) / Pasture (including range plants) / Cut and fed green / Silage
Scientific name : Genus	Gossypium
Species	herbaceum
Variety or kind	320F, 216F
Common name of feed	Kapas
	International Feed Reference No 58
Part of plant, animal or feed product	Seeds(Oil cake)
Process undergone before fed to animal	
Stage of maturity	240 days (Card 20)
Cutting or crop	1 Height when cut (centimeters) 0100 12
Official grade or No.	16 20 24
Fertilizer: kg per hectare	N 0015 P 0012 K 0012
Days between last application and harvest	28
Purity %	Chief contaminant
Soil classification	Field classification Alluvium 31
	Surface texture Sandy 34

Digestibility Trial

Animal: Kind	Fish (Labeo rohita) (Card 30 12)
Breed	Sex 15 18 19
Age:	Years 0 + Months Weeks 21
Number of animals in treatment	10 26
Total number of determinations per feed per animal	2 period No. 28 29
Average weight of animals, kg	or g 24.7 30
Physiological state:	non-pregnant / pregnant 1st 2/3 / pregnant last 1/3 36
	losing wt / maintaining wt / gaining wt / fattening 37

very thin / thin / thrifty / fat / very fat 39

Percent of test ingredient in ration fed (100.0% dry matter)	40
Ad Libitum feeding	✓ Controlled feeding 42
Feed fed alone	✓ Feed not fed alone, digestion by difference 43
Method: Total feces collection	feces indicator ✓ 44
Physical form of feed	Moist cake. 45
Basis for calculating level of feeding:	NE ME DE TDN 48
Length of trial:	Preliminary days 03 Collection days 03 49 51
Daily dry matter consumed	g kg 53
Daily dry matter offered	g kg 59
Daily orts or weighback	g kg 65
Temperature: Degrees C (indicate if negative)	026 71
Pressure: millimeters	74
Humidity: percent	78

Card 40

Dry Matter

		Dry Matter %	Method of analyses, if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff. %
✓ Dry matter of sample as fed basis	101	91.9	Above 105° C or in vacuum		

Dry Matter Basis on Which Analytical Data are Reported on This Form

Basis	Check one only		Fill in one only %
As fed	✓	102	
Partially dry		103	
Dry (100.0% dry matter)		104	

NOTE All analytical data on this sheet, except dry matter must be expressed as indicated i.e. as fed, partially dry, dry (100.0% dry matter). Where analytical data for one feed is partly on one basis and partly on another use separate sheet for each basis or convert to same basis

Proximate Principles

		%	Method of analyses, if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff. %
Ash	105	04.8	Assoc Official Agr Chem 1960		
Crude fiber	106	28.3	Weende		
Ether extract	107	05.6	Assoc Official Agr Chem 1960		
Nitrogen-free extract	108	20.2	By difference		
Protein	109	32.8	Kjeldahl		
Nitrogen	212		do		
Nitrogen factor	213	6.25	Write in factor to convert to protein		

Energy

		kcal per kg		
Gross energy	421	4719	Bomb calorimeter	
Digestible	422		Harris Natl. Acad. Sci. Natl. Res. Council pub. 1411 1966	
Metabolizable	423		do	
N-equilibrium metabolizable	424		do	
NE_m	426		Lofgreen J. Animal Sc. 27:793 1968	
NE_{gain}	427		do	
$NE_{lactating\ cows}$	430		Moe J. Dairy Sci. 52 928	
		%		
TDN	429		Biological	

Read instructions before filling in form.

Mail duplicate to Feed Information Center Food and Agriculture Organization of the United Nations (FAO, AGA) Via delle Terme di Caracalla 00100 Rome, Italy

Read instructions before filling in form.

Mail duplicate to
Feed Information Center
Food and Agriculture Organization of the United Nations (FAO, AGA)
Via delle Terme di Caracalla
00100 Rome, Italy

Table -IX

International Source Form for Composition of Feeds

(Please print)

Card 10

Project No. 645 Experiment No. FSA-1 Leader Prof.A.K.Jafri

Laboratory name Fish Nutrition Research Laboratory

Address Department of Zoology,
Aligarh Muslim University, Aligarh, India.

Laboratory director

Laboratory sample No. 3

Do not write in shaded areas.

For Code

Origin and Name of Sample

Date originally collected Month March Day Monday Year 1987

Country India

Region Northern India Altitude (meters) 184

State, province or department U.P.

County or district Aligarh

Literature reference ICAR-Handbook of Agriculture

Class: Dry forage (cut and cured) | Pasture (including range plants) | Cut and fed green | Silage

Scientific name: Genus Arachis

Species hypogea

Variety or kind Punjab 1

Common name of feed Mangfuli,Cheena badam.

International Feed Reference No

Part of plant, animal or feed product Pod(Oil cake)

Process undergone before fed to animal Drying, grinding, seiving

Stage of maturity 95 days

Card 20

Cutting or crop 1 Height when cut (centimeters) 0025

Official grade or No.

Fertilizer: kg per hectare N 0015 P 0030 K 0025

Days between last application and harvest

Purity % Chief contaminant

Soil classification Field classification Alluvium

Surface texture Loam/Sandy-loam

Digestibility Trial

Card 30

Animal: Kind Fish (Labeo rohita)

Breed Sex

Age: Years 0 + Months Weeks

Number of animals in treatment 10

Total number of determinations per feed per animal 2 period No.

Average weight of animals, kg or g 24.7

Physiological state: non-pregnant | pregnant 1st 2/3 | pregnant last 1/3

losing wt | maintaining wt | gaining wt | fattening

very thin | thin | thrifty | fat | very fat

Percent of test ingredient in ration fed (100.0% dry matter)

Ad Libitum feeding ✓ Controlled feeding

Feed fed alone ✓ Feed not fed alone, digestion by difference

Method: Total feces collection | feces indicator ✓

Physical form of feed Moist cake.

Basis for calculating level of feeding: NE | ME | DE | TDN

Length of trial: Preliminary days 03 Collection days 03

Daily dry matter consumed g kg

Daily dry matter offered g kg

Daily orts or weighback g kg

Temperature: Degrees C (indicate if negative) 026

Pressure: millimeters

Humidity: percent

Card 40

Dry Matter

	No.	Dry Matter %	Method of analyses; if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff %
✓ Dry matter of sample on as fed basis	101	93.6	Above 105° C or in vacuum		

Dry Matter Basis on Which Analytical Data are Reported on This Form

Basis	Check one only		Fill in one only %
As fed	✓	102	
Partially dry		103	
Dry (100.0% dry matter)		104	

NOTE: All analytical data on this sheet, except dry matter, must be expressed as indicated i.e.: as fed, partially dry, dry (100.0% dry matter). Where analytical data for one feed is partly on one basis and partly on another, use separate sheet for each basis or convert to same basis.

Proximate Principles

	No.	%	Method of analyses; if analysis was done by another method put under other analyses.	Anal. code factor	Digestion coeff %
Ash	105	06.7	Assoc Official Agr Chem 1960		
Crude fiber	106	08.2	Weende		
Ether extract	107	05.7	Assoc Official Agr Chem 1960		
Nitrogen-free extract	108	25.4	By difference		
Protein	109	47.4	Kjeldahl		
Nitrogen	212		do		
Nitrogen factor	213	6.25	Write in factor to convert to protein		

Energy

	No.	kcal per kg	Method		
Gross energy	421	4657	Bomb calorimeter		
Digestible	422	0083	Harris Natl Acad Sci Natl Res Council pub 1411 1966		
Metabolizable	423		do		
N-equilibrium metabolizable	424		do		
NE_m	426		Lofgreen J Animal Sci 27:793, 1968		
NE_{gain}	427		do		
$NE_{lactating\ cows}$	430		Moe J. Dairy Sci 52:928		
TDN	429	%	Biological		

Table X

International Source Form for Composition of Feeds

Project No. 645 **Experiment No.** FSA-1 **Leader** Prof.A.K.Jafri

Card 10

Laboratory name: Fish Nutrition Research Laboratory

Address: Department of Zoology, Aligarh Muslim University, Aligarh, India

Laboratory director:

Laboratory sample No: 4

Do not write in shaded areas. For Code

Origin and Name of Sample

Date originally collected: Month March Day Monday Year 1987

Country: India

Region: Borthern India Altitude (meters) 184

State, province or department: U.P.

County or district: Aligarh

Literature reference: ICAR-Handbook of Agriculture

Class: Dry forage (cut and cured) | Pasture (including range plants) | Cut and fed green | Silage

Scientific name: Genus Sesamum

Species indicum

Variety or kind: T-85, N-32

Common name of feed: Til

International Feed Reference No

Part of plant, animal or feed product: Seed (Oil cake)

Process undergone before fed to animal:

Stage of maturity: 135 days

Card 20

Cutting or crop: 1 Height when cut (centimeters) 0100

Official grade or No.

Fertilizer: kg per hectare N 0025 P 0020 K 0008

Days between last application and harvest

Purity %: Chief contaminant

Soil classification: Field classification

Surface texture: Sandy loam-heavy black soil

Digestibility Trial

Card 30

Animal: Kind Fish (Labeo rohita)

Breed: Sex:

Age: Years 0 + Months Weeks

Number of animals in treatment: 10

Total number of determinations per feed per animal: 2 period No.

Average weight of animals, kg or g 24.7

Physiological state: non-pregnant | pregnant 1st 2/3 | pregnant last 1/3

losing wt | maintaining wt | gaining wt | fattening

very thin | thin | thrifty | fat | very fat

Percent of test ingredient in ration fed (100.0% dry matter)

Ad Libitum feeding ✓ Controlled feeding

Feed fed alone ✓ Feed not fed alone, digestion by difference

Method: Total feces collection | feces indicator ✓

Physical form of feed: Moist cake.

Basis for calculating level of feeding: NE | ME | DE | TDN

Length of trial: Preliminary days 03 Collection days 03

Daily dry matter consumed g kg

Daily dry matter offered g kg

Daily orts or weighback g kg

Temperature: Degrees C (indicate if negative) 026

Pressure: millimeters

Humidity: percent

Card 40

Dry Matter

		Dry Matter %	Method of analyses, if one ... by another method put under ... analyses	Anal. code factor	Digestion coeff. %
✓ Dry matter of sample on as fed basis	101	97.1	Above 105° C or in vacuum		

Dry Matter Basis on Which Analytical Data are Reported on This Form

Basis	Check one only		Fill in one only %
As fed	✓	102	
Partially dry		103	
Dry (100.0% dry matter)		104	

NOTE: All analytical data on this sheet, except dry matter, must be expressed as indicated i.e. as fed, partially dry, dry(100.0% dry matter). Where analytical data for one feed is partly on one basis and partly on another use separate sheet for each basis or convert to same basis.

Proximate Principles

		%	Method of analyses, if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff %
Ash	105	10.5	Assoc Official Agr Chem 1960		
Crude fiber	106	15.4	Weende		
Ether extract	107	06.7	Assoc Official Agr Chem 1960		
Nitrogen-free extract	108	30.2	By difference		
Protein	109	34.2	Kjeldahl		
Nitrogen	212		do		
Nitrogen factor	213	6.25	Write in factor to convert to protein		

Energy

		kcal per kg			
Gross energy	421	4596	Bomb calorimeter		
Digestible	422		Harris Natl. Acad. Sci. Natl. Res Council pub. 1411 1966		
Metabolizable	423		do		
N-equilibrium metabolizable	424		do		
NE_m	426		Lofgreen J. Animal Sci 27:793. 1968		
NE_{gain}	427		do		
$NE_{lactating\ cows}$	430		Moe J. Dairy Sci 52:928		
		%			
TDN	429		Biological		

Read instructions before filling in form.

Mail duplicate to: Feed Information Centre, Food and Agriculture Organization of the United Nations (FAO, AGA), Via delle Terme di Caracalla, 00100 Rome, Italy

Table XI

International Source Form for Composition of Feeds

(Please print) Card 10

Project No. 645 Experiment No. FSA-1 Leader Prof.A.K.Jafri 12 17 22

Laboratory name Fish Nutrition Research Laboratory

Address Department of Zoology,
Aligarh Muslim University, Aligarh,India

Do not write in shaded areas.

For Code

Laboratory director

Laboratory sample No 5 24

Origin and Name of Sample

Date originally collected Month March Day Monday Year 1987 30

Country India 36

Region Northern India Altitude (meters) 184 39 42

State, province or department U.P. 46

County or district Aligarh 48

Literature reference ICAR-Handbook of Agriculture 51

Class: Dry forage (cut and cured) | Pasture (including range plants) | Cut and fed green | Silage

Scientific name: Genus Brassica

Species nigra

Variety or kind Type- 151

Common name of feed Sarson

International Feed Reference No 58

Part of plant, animal or feed product Seed (oil cake)

Process undergone before fed to animal Drying, grinding, seiving

Stage of maturity 155 days Card 20

Cutting or crop 1 Height when cut (centimeters) 0175 12

Official grade or No. 16 20 24

Fertilizer: kg per hectare N 0040 P ---- K ----

Days between last application and harvest 28

Purity % Chief contaminant

Soil classification Field classification Alluvium 31

Surface texture Light to heavy loam. 34

Digestibility Trial

Animal: Kind Fish (Labeo rohita) Card 30 12

Breed – Sex – 15 18

19

Age: Years 0 + Months Weeks 21

Number of animals in treatment 10 26

Total number of determinations per feed per animal 2 period No. 28 29

Average weight of animals, kg or g 24.7 30

Physiological state: non-pregnant | pregnant 1st 2/3 | pregnant last 1/3 36

losing wt | maintaining wt | gaining wt | fattening 37

very thin | thin | thrifty | fat | very fat 39

Percent of test ingredient in ration fed (100.0% dry matter) 40

Ad Libitum feeding ✓ Controlled feeding 42

Feed fed alone ✓ Feed not fed alone, digestion by difference 43

Method: Total feces collection | feces indicator ✓ 44

Physical form of feed Moist cake. 45

Basis for calculating level of feeding: NE | ME | DE | TDN 48

Length of trial: Preliminary days 03 Collection days 03 49 51

Daily dry matter consumed g kg 53

Daily dry matter offered g kg 59

Daily orts or weighback g kg 65

Temperature: Degrees C (indicate if negative) 026 71

Pressure: millimeters 74

Humidity: percent 78

Card 40

Dry Matter

		Dry Matter %	Method of analyses, if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff %
Dry matter of sample on as fed basis	101	93.3	Above 105° C or in vacuo		

Dry Matter Basis on Which Analytical Data are Reported on This Form

Basis	Check one only		Fill in one only %
As fed	✓	102	
Partially dry		103	
Dry (100.0% dry matter)		104	

NOTE: All analytical data on this sheet, except dry matter, must be expressed as indicated i.e. as fed, partially dry, dry(100.0% dry matter). Where analytical data for one feed is partly on one basis and partly on another, use separate sheet for each basis or convert to same basis.

Proximate Principles

		%	Method of analyses; if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff %
Ash	105	08.2	Assoc Official Agr Chem 1960		
Crude fiber	106	10.4	Weende		
Ether extract	107	09.6	Assoc Official Agr Chem 1960		
Nitrogen-free extract	108	29.0	By difference		
Protein	109	35.9	Kjeldahl		
Nitrogen	212		do		
Nitrogen factor	213	6.25	Write in factor to convert to protein		

Energy

		kcal per kg			
Gross energy	421	4748	Bomb calorimeter		
Digestible	422	0086	Harris Natl Acad Sci Natl Res Council pub. 1411 1966		
Metabolizable	423		do		
N-equilibrium metabolizable	424		do		
NE_m	426		Lofgreen J Animal Sci 27:793 1968		
NE_{gain}	427		do		
$NE_{lactating\ cows}$	430		Moe J Dairy Sci 52:928		

		%			
TDN	429		Biological		

Read instructions before filling in form.

Mail duplicate to Feed Information Center, Food and Agriculture Organization of the United Nations (FAO, AGA), Via delle Terme di Caracalla, 00100 Rome, Italy

Table XII

International Source Form for Composition of Feeds

Project No. 645 Experiment No. FSA-1 Leader Prof. A.K. Jafri (Please print) Card 10

Laboratory name Fish Nutrition Research Laboratory

Address Department of Zoology, Aligarh Muslim University, Aligarh, India

Laboratory director

Laboratory sample No. 6

Do not write in shaded areas. For Code

Origin and Name of Sample

Date originally collected Month March Day Monday Year 1987

Country India

Region Northern India Altitude (meters) 184

State, province or department U.P.

County or district Aligarh

Literature reference ICAR-Handbook of Agriculture

Class: Dry forage (cut and cured) | Pasture (including range plants) | Cut and fed green | Silage

Scientific name: Genus Cicer

Species arietinum

Variety or kind H 208, T 3, K 4

Common name of feed Chana, Chola

International Feed Reference No.

Part of plant, animal or feed product Seed (Husk, dust)

Process undergone before fed to animal Drying, grinding, seiving

Stage of maturity 150 days

Cutting or crop 1 Height when cut (centimeters) 0030

Official grade or No.

Fertilizer: kg per hectare N 0015 P 0025 K

Days between last application and harvest

Purity % Chief contaminant

Soil classification Field classification Alluvium

Surface texture Clayey-loam

Digestibility Trial

Animal: Kind Fish (Labeo rohita)

Breed Sex

Age: Years 0 + Months Weeks

Number of animals in treatment 10

Total number of determinations per feed per animal 2 period No.

Average weight of animals, kg or g 24.7

Physiological state: non-pregnant | pregnant 1st 2/3 | pregnant last 1/3

losing wt | maintaining wt | gaining wt | fattening

very thin | thin | thrifty | fat | very fat

Percent of test ingredient in ration fed (100.0% dry matter)

Ad Libitum feeding ✓ Controlled feeding

Feed fed alone ✓ Feed not fed alone, digestion by difference

Method: Total feces collection | feces indicator ✓

Physical form of feed Moist cake.

Basis for calculating level of feeding: NE ME DE TDN

Length of trial: Preliminary days 03 Collection days 03

Daily dry matter consumed g kg

Daily dry matter offered g kg

Daily orts or weighback g kg

Temperature: Degrees C (indicate if negative) 026

Pressure: millimeters

Humidity: percent

Card 40

Dry Matter

	No.	Dry Matter %	Method of analyses, if analysis was done by another method put under other analyses	Anal. code factor	Digest or coeff %
✓ Dry matter of sample on as fed basis	101	88.4	Above 105° C or in vacuum		

Dry Matter Basis on Which Analytical Data are Reported on This Form

Basis	Check one only		Fill in one only %
As fed	✓	102	
Partially dry		103	
Dry (100.0% dry matter)		104	

NOTE: All analytical data on this sheet, except dry matter, must be expressed as indicated i.e.: as fed, partially dry, dry (100.0% dry matter). Where analytical data for one feed is partly on one basis and partly on another use separate sheet for each basis or convert to same basis.

Proximate Principles

	No.	%	Method of analyses, if analysis was done by another method put under other analyses	Anal. code factor	Digest on coeff %
Ash	105	042	Assoc Official Agr Chem 1960		
Crude fiber	106	422	Weende		
Ether extract	107	004	Assoc Official Agr Chem 1960		
Nitrogen-free extract	108	370	By difference		
Protein	109	042	Kjeldahl		
Nitrogen	212		do		
Nitrogen factor	213	6.25	Write in factor to convert to protein		

Energy

	No.	kcal per kg	Method		
Gross energy	421	4037	Bomb calorimeter		
Digestible	422		Harris Natl. Acad. Sci. Natl. Res. Council pub. 1411 1966		
Metabolizable	423		do		
N-equilibrium metabolizable	424		do		
NE_m	426		Lofgreen J Animal Sci 27:793 1968		
NE_{gain}	427		do		
$NE_{lactating\ cows}$	430		Moe J Dairy Sci 52:928		
TDN	429	%	Biological		

Read instructions before filling in form.

Mail duplicate to Food and Agriculture Organization of the United Nations (FAO, AGA) Via delle Terme di Caracalla 00100 Rome, Italy

Table XIII

International Source Form for Composition of Feeds

Read instructions before filling in form.

Mail duplicate to Feed Information Center, Food and Agriculture Organization of the United Nations (FAO, AGA), Via delle Terme di Caracalla, 00100 Rome, Italy

Card 10

Project No. 645 **Experiment No.** FSA-1 **Leader** Prof. A.K.Jafri

Laboratory name: Fish Nutrition Research Laboratory

Address: Department of Zoology, Aligarh Muslim University, Aligarh, India

Laboratory director

Laboratory sample No. 7

Do not write in shaded areas.

For Code

Origin and Name of Sample

Date originally collected: Month March Day Monday Year 1987

Country: India

Region: Northern India Altitude (meters) 184

State, province or department: U.P.

County or district: Aligarh

Literature reference: ICAR-Handbook of Agriculture

Class: Dry forage (cut and cured) | Pasture (including range plants) | Cut and fed green | Silage

Scientific name: Genus: Lens

Species: culinaris

Variety or kind: T-36, Pant 209

Common name of feed: Musur

International Feed Reference No.

Part of plant, animal or feed product: Seed(Dust)

Process undergone before fed to animal: Drying, grinding, seiving

Stage of maturity: 100-120 days

Card 20

Cutting or crop: 1 Height when cut (centimeters): 0030

Official grade or No.

Fertilizer: kg per hectare N P 0040 K

Days between last application and harvest

Purity % Chief contaminant

Soil classification: Field classification Alluvium

Surface texture: Light loam

Digestibility Trial

Card 30

Animal: Kind Fish (Labeo rohita)

Breed Sex

Age: Years 0 + Months Weeks

Number of animals in treatment: 10

Total number of determinations per feed per animal: 2 period No.

Average weight of animals, kg or g 24.7

Physiological state: non-pregnant | pregnant 1st 2/3 | pregnant last 1/3

losing wt | maintaining wt | gaining wt | fattening

very thin | thin | thrifty | fat | very fat

Percent of test ingredient in ration fed (100.0% dry matter)

Ad Libitum feeding ✓ Controlled feeding

Feed fed alone ✓ Feed not fed alone, digestion by difference

Method: Total feces collection | feces indicator ✓

Physical form of feed: Moist cake.

Basis for calculating level of feeding: NE | ME | DE | TDN

Length of trial: Preliminary days 03 Collection days 03

Daily dry matter consumed g kg

Daily dry matter offered g kg

Daily orts or weighback g kg

Temperature: Degrees C (indicate if negative) 026

Pressure: millimeters

Humidity: percent

Card 40

Dry Matter

	Code	Dry Matter %	Method of analyses, if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff. %
✓ Dry matter of sample on "as fed" basis	101	91.9	Above 105° C or in vacuum		

Dry Matter Basis on Which Analytical Data are Reported on This Form

Basis	Check one only	Code	Fill in one only %
As fed	✓	102	
Partially dry		103	
Dry (100.0% dry matter)		104	

NOTE: All analytical data on this sheet, except dry matter, must be expressed as indicated i.e. as fed, partially dry, dry(100.0% dry matter). Where analytical data for one feed is partly on one basis and partly on another, use separate sheet for each basis or convert to same basis.

Proximate Principles

	Code	%	Method of analyses, if analysis was done by another method put under other analyses.	Anal. code factor	Digestion coeff. %
Ash	105	054	Assoc. Official Agr. Chem. 1960		
Crude fiber	106	071	Weende		
Ether extract	107	014	Assoc. Official Agr. Chem. 1960		
Nitrogen-free extract	108	472	By difference		
Protein	109	306	Kjeldahl		
Nitrogen	212		do		
Nitrogen factor	213	625	Write in factor to convert to protein		

Energy

	Code	kcal per kg	Method		
Gross energy	421	4360	Bomb calorimeter		
Digestible	422		Harris Natl. Acad. Sci. Natl. Res. Council pub. 1411. 1966		
Metabolizable	423		do		
N-equilibrium metabolizable	424		do		
NE_m	426		Lofgreen J. Animal Sci. 27:793. 1968		
NE_{gain}	427		do		
$NE_{lactating\ cows}$	430		Moe J. Dairy Sci. 52:928		
TDN	429	%	Biological		

Read instructions before filling in form.

Mail duplicate to
Food and Agriculture Organization of the United Nations (FAO, AGA)
Via delle Terme di Caracalla
00100 Rome, Italy

Table XIV
International Source Form for Composition of Feeds

Card 10

Project No. 645 **Experiment No.** FSA-1 **Leader** Prof. A.K.Jafri (Please print) 12 17 22

Laboratory name Fish Nutrition Research Laboratory

Address Department of Zoology,
Aligarh Muslim University, Aligarh, India

Do not write in shaded areas.

Laboratory director

For Code

Laboratory sample No. 8 24

Origin and Name of Sample

Date originally collected Month March Day Monday Year 1987 30

Country India 36

Region Northern India Altitude (meters) 184 39 42

State, province or department U.P. 46

County or district Aligarh 48

Literature reference ICAR-Handbook of Agriculture 51

Class Dry forage (cut and cured) | Pasture (including range plants) | Cut and fed green | Silage

Scientific name: Genus Cajanus

Species cajan

Variety or kind T-21, Pant-A3

Common name of feed Arhar

International Feed Reference No. 58

Part of plant, animal or feed product Seed(Dust)

Process undergone before fed to animal Drying, grinding, seiving

Stage of maturity 150 days

Card 20

Cutting or crop 1 Height when cut (centimeters) 0 1 5 0 12

Official grade or No. 16 20 24

Fertilizer: kg per hectare N P K

Days between last application and harvest 28

Purity % Chief contaminant

Soil classification Field classification Alluvium 31

Surface texture Loamy 34

Digestibility Trial

Card 30 12

Animal: Kind Fish (Labeo rohita) 15 18

Breed Sex 19

Age: Years 0+ Months 10 Weeks 21

Number of animals in treatment 26

Total number of determinations per feed per animal 2 period No. 28 29

Average weight of animals, kg or g 2 4 . 7 30

Physiological state: non-pregnant | pregnant 1st 2/3 | pregnant last 1/3 36

losing wt | maintaining wt | gaining wt | fattening 37

very thin | thin | thrifty | fat | very fat 39

Percent of test ingredient in ration fed (100.0% dry matter) 40

Ad Libitum feeding ✓ Controlled feeding 42

Feed fed alone ✓ Feed not fed alone, digestion by difference 43

Method: Total feces collection feces indicator ✓ 44

Physical form of feed Moist cake. 45

Basis for calculating level of feeding: NE ME DE TDN 48

Length of trial: Preliminary days 0 3 Collection days 0 3 49 51

Daily dry matter consumed g kg 53

Daily dry matter offered g kg 59

Daily orts or weighback g kg 65

Temperature: Degrees C (indicate if negative) 0 2 6 71

Pressure: millimeters 74

Humidity: percent 78

Card 40

Dry Matter

		Dry Matter %	Method of analyses, if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff. %
Dry matter of sample on "as fed" basis	101	9 1.8	Above 105° C or in vacuum		

Dry Matter Basis on Which Analytical Data are Reported on This Form

Basis	Check one only		Fill in one only %
As fed	✓	102	
Partially dry		103	
Dry (100.0% dry matter)		104	

NOTE All analytical data on this sheet, except dry matter, must be expressed as indicated i.e. as fed, partially dry, dry(100.0% dry matter). Where analytical data for one feed is partly on one basis and partly on another, use separate sheet for each basis or convert to same basis.

Proximate Principles

		%	Method of analyses, if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff. %
Ash	105	0 5.4	Assoc. Official Agr. Chem. 1960		
Crude fiber	106	2 5.7	Weende		
Ether extract	107	0 2.4	Assoc. Official Agr. Chem. 1960		
Nitrogen-free extract	108	4 4.2	By difference		
Protein	109	1 3.9	Kjeldahl		
Nitrogen	212		do		
Nitrogen factor	213	6.2 5	Write in factor to convert to protein		

Energy

		kcal per kg			
Gross energy	421	3 8 0 0	Bomb calorimeter		
Digestible	422		Harris Natl. Acad. Sci. Natl. Res. Council pub. 1411. 1966		
Metabolizable	423		do		
N-equilibrium metabolizable	424		do		
NE_m	426		Lofgreen J. Animal Sci. 27:793. 1968		
NE_{gain}	427		do		
$NE_{lactating\ cows}$	430		Moe J. Dairy Sci. 52:928		

		%			
TDN	429		Biological		

Table XV

International Source Form for Composition of Feeds

(Please print) Card 10

Project No. 645 **Experiment No.** FSA-1 **Leader** Prof. A.K.Jafri 12 17

Laboratory name Fish Nutrition Research Laboratory 22

Address Department of Zoology,
Aligarh Muslim University, Aligarh, India

Do not write in shaded areas

Laboratory director

For Code

Laboratory sample No 9 24

Origin and Name of Sample

Date originally collected Month March Day Monday Year 1987 30

Country India 36

Region Northern India Altitude (meters) 184 39 42

State, province or department U.P. 46

County or district Aligarh 48

Literature reference ICAR-Handbook of Agriculture 51

Class: Dry forage (cut and cured) | Pasture (including range plants) | Cut and fed green | Silage

Scientific name: Genus Trifolium

Species alexandrium

Variety or kind

Common name of feed Barseem

International Feed Reference No 58

Part of plant, animal or feed product Leaves

Process undergone before fed to animal Drying, grinding, seiving

Stage of maturity 60 - 70 days Card 20

Cutting or crop 5 Height when cut (centimeters) 0070 12

Official grade or No. 16 20 24

Fertilizer: kg per hectare N 0020 P 0025 K 0050

Days between last application and harvest 28

Purity % Chief contaminant

Soil classification Field classification Alluvium 31

Surface texture Loamy 34

Digestibility Trial

Animal: Kind Fish (Labeo rohita) Card 30 12

Breed Sex 15 18 19

Age: Years 0 + Months Weeks 21

Number of animals in treatment 10 26

Total number of determinations per feed per animal 2 period No. 28 29

Average weight of animals, kg or g 24.7 30

Physiological state: non-pregnant | pregnant 1st 2/3 | pregnant last 1/3 36

losing wt | maintaining wt | gaining wt | fattening 37

very thin | thin | thrifty | fat | very fat 39

Percent of test ingredient in ration fed (100.0% dry matter) 40

Ad Libitum feeding ✓ Controlled feeding 42

Feed fed alone ✓ Feed not fed alone, digestion by difference 43

Method: Total feces collection | feces indicator ✓ 44

Physical form of feed Moist cake. 45

Basis for calculating level of feeding: NE | ME | DE | TDN 48

Length of trial: Preliminary days 03 Collection days 03 49 51

Daily dry matter consumed g kg 53

Daily dry matter offered g kg 59

Daily orts or weighback g kg 65

Temperature: Degrees C (indicate if negative) 026 71

Pressure: millimeters 74

Humidity: percent 78

Card 40

Dry Matter

✓ Dry matter of sample on as fed basis 101

Dry Matter %	Method of analyses, if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff %
	Above 105° C or in vacuum		

Dry Matter Basis on Which Analytical Data are Reported on This Form

Basis	Check one only		Fill in one only %
As fed	✓	102	
Partially dry		103	
Dry (100.0% dry matter)		104	

NOTE: All analytical data on this sheet, except dry matter, must be expressed as indicated i.e.: as fed, partially dry, dry (100.0% dry matter). Where analytical data for one feed is partly on one basis and partly on another, use separate sheet for each basis or convert to same basis

Proximate Principles

		%	Method of analyses; if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff %
Ash	105		Assoc Official Agr Chem 1960		
Crude fiber	106		Weende		
Ether extract	107		Assoc Official Agr Chem 1960		
Nitrogen-free extract	108		By difference		
Protein	109		Kjeldahl		
Nitrogen	212		do		
Nitrogen factor	213		Write in factor to convert to protein		

Energy

		kcal per kg			
Gross energy	421	4559	Bomb calorimeter		
Digestible	422		Harris Natl. Acad. Sci. Natl. Res Council pub. 1411. 1966		
Metabolizable	423		do		
N-equilibrium metabolizable	424		do		
NE_m	426		Lofgreen J. Animal Sci 27:793. 1968		
NE_{gain}	427		do		
$NE_{lactating\ cows}$	430		Moe J. Dairy Sci. 52:928		
		%			
TDN	429		Biological		

Feed Information Center
Food and Agriculture Organization of the United Nations (FAO, AGA)
Via delle Terme di Caracalla
00100 Rome, Italy

Mail duplicate to

Read instructions before filling in form.

Table XVI

International Source Form f... ...osition of feeds (Please print)

Card 10

Project No. 645 **Experiment No.** FSA-1 **Leader** Prof. A.K.Jafri

Laboratory name Fish Nutrition Research Laboratory

Address Department of Zoology, Aligarh Muslim University, Aligarh, India

Laboratory director

Laboratory sample No. 10

Do not write in shaded areas. For Code

Origin and Name of Sample

Date originally collected Month March Day Monday Year 1987

Country India

Region Northern India Altitude (meters) 184

State, province or department U.P.

County or district Aligarh

Literature reference ICAR-Handbook of Agriculture

Class: Dry forage (cut and cured) | Pasture (including range plants) | Cut and fed green | Silage

Scientific name: Genus Triticum

Species aestivum

Variety or kind Sonalika

Common name of feed Gehun, Gam

International Feed Reference No

Part of plant, animal or feed product Grain (Bran)

Process undergone before fed to animal Drying, grinding, selving

Card 20

Stage of maturity 90 days

Cutting or crop 1 Height when cut (centimeters) 0080

Official grade or No.

Fertilizer: kg per hectare N 0070 P 0035 K 0022

Days between last application and harvest

Purity % Chief contaminant

Soil classification Field classification Alluvium

Surface texture Loamy

Digestibility Trial

Card 30

Animal: Kind Fish (Labeo rohita)

Breed Sex

Age: Years 0 + Months Weeks

Number of animals in treatment 10

Total number of determinations per feed per animal 2 period No.

Average weight of animals, kg or g 24.7

Physiological state: non-pregnant | pregnant 1st 2/3 | pregnant last 1/3

losing wt | maintaining wt | gaining wt | fattening

very thin | thin | thrifty | fat | very fat

Percent of test ingredient in ration fed (100.0% dry matter)

Ad Libitum feeding ✓ Controlled feeding

Feed fed alone ✓ Feed not fed alone, digestion by difference

Method: Total feces collection | feces indicator ✓

Physical form of feed Moist cake.

Basis for calculating level of feeding: NE | ME | DE | TDN

Length of trial: Preliminary days 03 Collection days 03

Daily dry matter consumed g kg

Daily dry matter offered g kg

Daily orts or weighback g kg

Temperature: Degrees C (indicate if negative) 026

Pressure: millimeters

Humidity: percent

Card 40

Dry Matter

✓ Dry matter of sample on as fed basis 101

Dry Matter %	Method of analyses; if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff %
89.1	Above 105° C or in vacuum		

Dry Matter Basis on Which Analytical Data are Reported on This Form

Basis	Check one only		Fill in one only %
As fed	✓	102	
Partially dry		103	
Dry (100 0% dry matter)		104	

NOTE: All analytical data on this sheet, except dry matter, must be expressed as indicated i.e. as fed, partially dry, dry(100 0% dry matter). Where analytical data for one feed is partly on one basis and partly on another use separate sheet for each basis or convert to same basis

Proximate Principles

		%	Method of analyses; if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff %
Ash	105	06.1	Assoc. Official Agr. Chem 1960		
Crude fiber	106	10.2	Weende		
Ether extract	107	04.8	Assoc. Official Agr. Chem 1960		
Nitrogen-free extract	108	51.9	By difference		
Protein	109	15.8	Kjeldohl		
Nitrogen	212		do		
Nitrogen factor	213	6.25	Write in factor to convert to protein		

Energy

		kcal per kg			
Gross energy	421	4518	Bomb calorimeter		
Digestible	422	0084	Harris Natl. Acad. Sci. Natl. Res. Council pub. 1411 1966		
Metabolizable	423		do		
N-equilibrium metabolizable	424		do		
NE_m	426		Lofgreen J. Animal Sci. 27:793. 1968		
NE_{gain}	427		do		
$NE_{lactating\ cows}$	430		Moe J. Dairy Sci. 52:928		
		%			
TDN	429		Biological		

Read instructions before filling in form.

Mail duplicate to Feed Information Centre, Food and Agriculture Organization of the United Nations (FAO, AGA), Via delle Terme di Caracalla, 00100 Rome, Italy

Table XVII

International Source Form for Composition of Feeds

(Please print) Card 10

Project No. 645 **Experiment No.** FSA-1 **Leader** Prof. A.K. Jafri 12 17 22

Laboratory name Fish Nutrition Research Laboratory

Address Department of Zoology,
Aligarh Muslim University, Aligarh, India

Do not write in shaded areas.

For Code

Laboratory director

Laboratory sample No. 11 24

Origin and Name of Sample

Date originally collected Month March Day Monday Year 1987 30

Country India 36

Region Northern India Altitude (meters) 184 39 42

State, province or department U.P. 46

County or district Aligarh 48

Literature reference ICAR-Handbook of Agriculture 51

Class: Dry forage (cut and cured) | Pasture (including range plants) | Cut and fed green | Silage

Scientific name : Genus Oryza

Species sativa

Variety or kind IR-8

Common name of feed Dhan, Chawal

International Feed Reference No 58

Part of plant, animal or feed product Grains(Polish,Bran)

Process undergone before fed to animal Drying, grinding, seiving

Stage of maturity 85-90 days Card 20

Cutting or crop 1 Height when cut (centimeters) 0065 12

Official grade or No. 16 20 24

Fertilizer: kg per hectare N 0090 P 0045 K

Days between last application and harvest 28

Purity % Chief contaminant

Soil classification Field classification Alluvium 31

Surface texture Clayey loam 34

Digestibility Trial

Animal: Kind Fish (Labeo rohita) Card 30 12

Breed Sex 15 18 19

Age: Years 0 + Months Weeks 21

Number of animals in treatment 10 26

Total number of determinations per feed per animal 2 period No. 28 29

Average weight of animals, kg or g 24.7 30

Physiological state: non-pregnant | pregnant 1st 2/3 | pregnant last 1/3 36

losing wt | maintaining wt | gaining wt | fattening 37

very thin | thin | thrifty | fat | very fat 39

Percent of test ingredient in ration fed (100.0% dry matter) 40

Ad Libitum feeding ✓ Controlled feeding 42

Feed fed alone ✓ Feed not fed alone, digestion by difference 43

Method: Total feces collection | feces indicator ✓ 44

Physical form of feed Moist cake. 45

Basis for calculating level of feeding: NE | ME | DE | TDN 48

Length of trial: Preliminary days 03 Collection days 03 49 51

Daily dry matter consumed g kg 53

Daily dry matter offered g kg 59

Daily orts or weighback g kg 65

Temperature: Degrees C (indicate if negative) 026 71

Pressure: millimeters 74

Humidity: percent 78

Card 40

Dry Matter

		Dry Matter %	Method of analyses, if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff %
✓ Dry matter of sample on as fed basis	101	96.7	Above 105° C or in vacuum		

Dry Matter Basis on Which Analytical Data are Reported on This Form

Basis	Check one only		Fill in one only %
As fed	✓	102	
Partially dry		103	
Dry (100 0% dry matter)		104	

NOTE: All analytical data on this sheet, except dry matter, must be expressed as indicated i e : as fed, partially dry, dry(100 0% dry matter). Where analytical data for one feed is partly on one basis and partly on another use separate sheet for each basis or convert to same basis

Proximate Principles

		%	Method of analyses, if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff %
Ash	105	144	Assoc Official Agr Chem 1960		
Crude fiber	106		Weende		
Ether extract	107	018	Assoc Official Agr Chem 1960		
Nitrogen-free extract	108		By difference		
Protein	109	058	Kjeldahl		
Nitrogen	212		do		
Nitrogen factor	213	625	Write in factor to convert to protein		

Energy

		kcal per kg			
Gross energy	421	3502	Bomb calorimeter		
Digestible	422	0080	Harris Natl Acad. Sci Natl. Res Council pub 1411 1966		
Metabolizable	423		do		
N-equilibrium metabolizable	424		do		
NE_m	426		Lofgreen J Animal Sci 27:793. 1968		
NE_{gain}	427		do		
$NE_{lactating\ cows}$	430		Moe J Dairy Sci 52:928		
		%			
TDN	429		Biological		

Read instructions before filling in form.

Mail duplicate to Feed Information Center Food and Agriculture Organization of the United Nations (FAO, AGA) Via delle Terme di Caracalla 00100 Rome, Italy

Table XVIII

International Source Form for Composition of Feeds

Read instructions before filling in form.

Mail duplicate to: Feed Information Center, Food and Agriculture Organization of the United Nations (FAO, AGA), Via delle Terme di Caracalla, 00100 Rome, Italy

Project No. 645 Experiment No. FSA-1 Leader Prof. A.K. Jafri Card 10

Laboratory name Fish Nutrition Research Laboratory

Address Department of Zoology, Aligarh Muslim University, Aligarh, India

Do not write in shaded areas. For Code

Laboratory director

Laboratory sample No. 12

Origin and Name of Sample

Date originally collected Month March Day Monday Year 1987

Country India

Region Northern India Altitude (meters) 184

State, province or department U.P.

County or district Aligarh

Literature reference ICAR-Handbook of Agriculture

Class: Dry forage (cut and cured) | Pasture (including range plants) | Cut and fed green | Silage

Scientific name: Genus Hordeum Species vulgare

Variety or kind Kailash

Common name of feed Jow

International Feed Reference No.

Part of plant, animal or feed product Grains (Dust)

Process undergone before fed to animal Drying, grinding, selving

Stage of maturity 100 days Card 20

Cutting or crop 1 Height when cut (centimeters) 0190

Official grade or No.

Fertilizer: kg per hectare N 0025 P 0020 K 0020

Days between last application and harvest

Purity % Chief contaminant

Soil classification Field classification Alluvium Surface texture Moderately rich loam

Digestibility Trial

Animal: Kind Fish (Labeo rohita) Card 30

Breed Sex

Age: Years 0 + Months Weeks

Number of animals in treatment 10

Total number of determinations per feed per animal 2 period No.

Average weight of animals, kg or g 24.7

Physiological state: non-pregnant | pregnant 1st 2/3 | pregnant last 1/3

losing wt | maintaining wt | gaining wt | fattening

very thin | thin | thrifty | fat | very fat

Percent of test ingredient in ration fed (100.0% dry matter)

Ad Libitum feeding ✓ Controlled feeding

Feed fed alone ✓ Feed not fed alone, digestion by difference

Method: Total feces collection feces indicator ✓

Physical form of feed Moist cake.

Basis for calculating level of feeding: NE | ME | DE | TDN

Length of trial: Preliminary days 03 Collection days 03

Daily dry matter consumed g kg

Daily dry matter offered g kg

Daily orts or weighback g kg

Temperature: Degrees C (indicate if negative) 026

Pressure: millimeters

Humidity: percent

Card 40

Dry Matter

		Dry Matter %	Method of analyses, if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff %
Dry matter of sample on as fed basis	101	89.8	Above 105° C in vacuum		

Dry Matter Basis on Which Analytical Data are Reported on This Form

NOTE: All analytical data on this sheet, except dry matter must be expressed as indicated i.e. as fed, partially dry, dry (100.0% dry matter). Where analytical data for one feed is partly on one basis and partly on another use separate sheet for each basis or convert to same basis.

Basis	Check one only		Fill in one only %
As fed	✓	102	
Partially dry		103	
Dry (100.0% dry matter)		104	

Proximate Principles

		%	Method of analyses, if analysis was done by another method put under other analyses	Anal. code factor	Digestion coeff %
Ash	105	03.5	Assoc Official Agr Chem 1960		
Crude fiber	106	08.6	Weende		
Ether extract	107	00.6	Assoc Official Agr Chem 1960		
Nitrogen-free extract	108	69.2	By difference		
Protein	109	07.9	Kjeldahl		
Nitrogen	212		do		
Nitrogen factor	213	6.25	Write in factor to convert to protein		

Energy

		kcal per kg			
Gross energy	421	4036	Bomb calorimeter		
Digestible	422		Harris Natl. Acad. Sci. Natl. Res. Council pub. 1411 1966		
Metabolizable	423		do		
N-equilibrium metabolizable	424		do		
NE_m	426		Lofgreen J. Animal Sci. 27:793 1968		
NE_{gain}	427		do		
$NE_{lactating\ cows}$	430		Moe J. Dairy Sci. 52:928		
		%			
TDN	429		Biological		

CHAPTER - II

ENERGY REQUIREMENT OF THE INDIAN MAJOR CARP, LABEO ROHITA (HAM)

INTRODUCTION

Livestock and poultry nutritionists have long recognised the importance of meeting the energy requirements of animals in formulating practical diets. Various feeding tables listing the allowance for energy and other nutrients are available for the farm animals. Relatively little information is available on the energy requirements of fish (Adron et al., 1976; Marries and Kissil, 1979; Cho and Kaushik, 1985; Machiels and Henken, 1985; Daniels and Robinson, 1986; Barrows et al., 1988; and Colosso et al., 1988). Fish nutritionists have generally given priority to meeting the requirements for protein, minerals and vitamins, although it has been recognised that deficient energy level in the ration many lead to less efficient utilization of protein and other nutrients by the fish. Intake of higher than the required energy may cause excessive fat deposition (Adron et al., 1976; Garling and Wilson, 1976, and Takeuchi et al., 1978a,b,c).

Fish, like other animals, are known to eat to meet their energy requirements (Lee and Putnam, 1973; and Page and Andrews, 1973) and thus have the capability of compensating for a low energy density in food by eating more of it, provided the food is nutritionally balanced. Such a compensation, however, occurs up to the physical limit of the digestive tract, although a high energy density diet will require less feed per unit of weight gained. However, maximal physical intake of high energy density diet sustains a higher growth rate. Provision of an optimal balance of energy components in diet is, therefore, important from the view point of fish production and the cost-effectiveness of the culture system.

Fish are ammoniotelic animals and can readily use protein as an energy source. In the event of disproportionately high protein to non-protein energy ratio in diet, greater utilization of protein may occur, leading to an excessive concentration of ammonia in the culture system (Beamish and Thomas, 1984).

A deficiency of non-protein energy sources (lipid and carbohydrate) in diet may retard growth rate (Lovell, 1976), since protein will then be used more for energy purposes rather than for protein synthesis. Similarly, if the diet contains an excess of non-protein energy, appetite or demand may be satisfied before a sufficient quantity of protein (and also other nutrients) is ingested to satisfy demand for protein synthesis and growth. In an exhaustive review on protein requirements of fish, Wilson and Halver (1986) emphasized that dietary protein requirement for fish may also be influenced by the dietary protein to energy balance. Estimation of protein energy ratio in the diet for optimum growth of the fish is thus an important aspect in fish nutritional studies.

Besides protein to energy ratio in diet, several other factors may influence the energy requirement of fish. It has been pointed out that, in identical condition, the energy requirement varies with the species (Beamish, 1964; Dean and Goodnight, 1964; and Brett and Groves, 1979). Temperature, by altering the kinetics of metabolic reaction, has a direct influence on the energy requirement, as measured by increased or decreased growth rates, respiratory or oxygen consumption (Rozin and Mayer, 1961; Dean and Goodnight, 1964; and Brett, 1965). The energy requirement is also reported to be size and/or age dependent (Brown, 1957; Brett et al., 1969; Pandian, 1967, 1970; de Silva and Balbontin, 1974).

Several studies have been made in the past to assess the effect of total energy intake on the growth and conversion efficiencies of different species of fish. Although the gross protein requirement of the Indian major carp, L. rohita, has been reported in the past (Sen et al., 1978; and Renukaradhya and Varghese, 1986), no information is available on the energy requirements of this species. Intensification of carp aquaculture would require the use of well-balanced formulated feed as per the requirement of the species. The lack of data on complete nutritional requirements of Indian major carp is one of the major technical constraints in the development of least-cost and nutritionally adequate production diet for this group of fish.

The present study deals with the effect of different energy levels on the growth and conversion efficiencies, leading to optimization of an energy: protein ratio in L. rohita. Knowledge of energy requirement of this fish at a given protein level would be useful in identifying the best calorie-to-protein ratio, as also in balancing the energy and protein components, while formulating practical diets for the above species.

MATERIALS AND METHODS

I. Source of fish and acclimatization of test lots

Fingerlings of *L. rohita* were obtained from the Uttar Pradesh Fish Seed Centre, Kolahar, Mathura. These were transported to the laboratory in oxygen filled polythene bags and stocked in earthen fish pond (12 x 6 x 1.5 m). Supplementary feeding at the level of 5% of the biomass was carried out using the conventional, rice bran: mustard oil cake (1 : 1) feed mixture, daily at 0800 h. The required number of fingerlings were transferred to the wet laboratory, disinfected with 5 ppm $KMnO_4$ solution and acclimatized on casein-gelatin test diet for about two weeks.

II. Preparation of experimental diets

The reported gross protein requirements of *L. rohita* is around 40-45% of the diet (Sen *et al.*, 1978; Renukaradhya and Varghese, 1986). Based on these finding, three approximately iso-nitrogenous diets were prepared, using casein and gelatin as the protein source (Mertz, 1972), to work out the energy requirement of this species. The energy level in the experimental diets ranged from 3390 - 3870 cal/g dry diet (Table I). The mineral and vitamin premixes (Table II,III)were prepared according to Halver (1976). The protein to energy (P/E) ratios in the experimental diets ranged from 75.1 - 86.0 kcal/mg protein.

The calculated quantities of various dietary ingredients were weighed on an electronic balance. A known quantity of water was then taken in a stainless steel attachment of Hobart electric mixer and heated to 80°C. Gelatin was dissolved into it with slow stirring and heating the content on to a double boiler unit. The mixer bowl was removed from heating, dextrin and mineral mix added to it, and the content blended in Hobart mixer while still in lukewarm state. This was followed by the addition of remaining ingredients. As the diet began to solidify, the speed of stirring was increased gradually to incorporate air into the mixture. The final diet, about the consistency of bread dough, was poured into a teflon-coated pan and placed in a refrigerator to jell.

For the preparation of crumbles, the above material was cold extruded through Hobart extruder fitted with 1 mm die. The strands were spread over the receiving tray and placed in hot air oven at 60°C. The diet upon drying were crumbled and sieved through ASTM-18 and ASTM-30 screens, and stored in sealed plastic bags in a freezer until used.

III. Feeding trial

Fingerlings (2.9-5.3 cm total length) were sorted out from the acclimatized fish lot maintained in the wet laboratory and stocked in 70 l high density polyvinyl circular troughs (water volume 55 l) fitted with a continuous water flow-through system. The stocking density was 100 fish per trough. The water exchange rate in each trough was maintained at 1-1.5 l/min. The bottom of the trough was siphoned off every morning to remove unused food, if any, and the faecal matter. A natural light : dark cycle was maintained.

The fish were fed test diet crumbles at the rate of 3% body weight daily at 0800 and 1600 h, except on the day when weekly measurements were taken. The feeding level and feeding schedule were chosen after carefully observing the feeding behaviour of the fish and their dietary intake. Feeding allowances were adjusted on weekly basis. Care was taken to ensure that diet crumbles were quickly consumed. Accumulation of diet at the bottom was avoided to prevent any possible leaching of the nutrients. A thorough scrubbing and cleaning of each trough was also carried out weekly. The average water temperature and dissolved oxygen over the 6-week feeding trial, based on daily measurements, ranged between 24-28°C and 6.3 - 6.8 ppm, respectively.

Survival was 100% in all the dietary treatments.

IV. Assessment of nutritional parameters

One of the criteria chosen to ascertain the performance of feed was the assessment of growth obtained by subtracting the initial weight of biomass from its final weight over a particular duration of feed trial.

The specific growth rate (%) was evaluated using the formula:

$$SGR\ (\%) = \frac{W_2 - W_1}{D} \times 100$$

Where W_1 = Initial weight of biomass (g)

W_2 = Final weight of biomass (g)

D = Duration of feed trial (days)

The food conversion ratio (FCR) was calculated on the basis of the ratio of food consumed to live weight gained by the fish. The gross growth efficiency represented the ratio of live weight gain to food consumed. The protein efficiency ratio (PER) was calculated on the basis of the ratio of protein consumed to live weight gained.

RESULTS

Results of the 6-week feeding trial conducted on *L. rohita* to quantify its energy requirement has been summarized in Table IV.

The average weight of fish over the experimental period for the test diets used increased linearly on their initial weight (Fig. I). The fish registered the maximum gain in live weight with 3500 cal/g dry diet energy level. The lowest gain was recorded with 3870 cal/g dietary energy. The weekly mean live weight gain per cent for different treatments have been plotted in Fig. II . In terms of percentage, the maximum (89%), gain, occurred in fish fed 3500 cal/g energy diet, whereas it was only 72% at high (3870 cal/g) dietary energy intake.

The average specific growth rate (%) of fish at various energy intakes have been depicted in Fig. III. The specific growth rate increased linearly with increasing dietary energy content up to the incorporation rate of 3500 cal/g and declined sharply at 3870 cal/g energy intake.

The FCR and gross growth efficiency in fish fed different levels of energy have been shown in Fig. IV . Marked differences were seen in the food conversion values. The best (2.1) FCR was noted at 3500 cal/g dietary energy level. Less efficient conversion was obtained with diets having levels of higher or lower to the requirement (3500 cal/g). The gross growth efficiency and the PER were likewise maximum, 0.48 and 1.15, respectively, at the above level of dietary energy.

Fat and water contents of the carcass was found affected with the levels of energy intake (Table IV). These two constituents also indicated a negative relationship with each other. Highest (32% dry weight) amount of crude fat, noted in the carcass of fish fed diet containing 3870 cal/g energy, was accompanied with lowest percentage of water.

DISCUSSION

The maintenance energy needs of fish are considerably lower than those of homeothermic animals (Cho and Kaushik, 1985). However, compared to higher vertebrates, usually a high proportion of heat production is derived from dietary protein. Although the utilization of protein for basal energy metabolism is an established phenomenon in fish, conventional energy yielding nutrients like fats and carbohydrates can reduce the oxidation of protein to satisfy the energy needs of fish and thus improve the utilization of dietary protein for growth (Cowey, 1975; and Watanabe, 1977). The beneficial effects of incorporating such protein-sparing nutrients have been widely studied (Lee and Putnam, 1973; Takeuchi et al.,1978 a,b,c; 1979; Bromley, 1980; Millikin, 1983; and Beamish and Medland, 1986), and optimal ratios between protein and energy proposed for many species of fish (Cho and Kaushik, 1985).

It would appear, both from the plot of average fish weight against time as well as the pattern of changes observed in the specific growth rate, that the level of energy producing the maximum growth in *L. rohita* is around 3500 cal/g. However, further increase of dietary energy intake to 3870 cal/g resulted in smaller gain than that observed at the low energy (3390 cal/g) intake. The findings are in conformity to the results reported by Barrows *et al.* (1988) on Walleye fingerlings. Takeuchi *et al.* (1978 b) and Millikin (1983) noticed similar effects of dietary energy on weight gains in rainbow trout and striped bass, respectively.

The results of the present study indicates that a proper balance between energy and protein is important for optimum growth and feed efficiency of *L. rohita*, as is true for other fish species. The energy to protein ratio of 83.3 (kcal/mg protein) recorded for the maximum growth of this species is identical to the value reported for small-sized common carp (Takeuchi et al., 1978d and Lovell, 1984b). Garling and Wilson (1977), using purified diets, reported the optimum energy to protein ratio for the growth of young channel catfish to be 96, while Page and Andrews (1973), using practical diets, found the value to be 97. Stickney and Lovell (1977), on the other hand, recommended energy requirement of 80 to 90 kcal/mg of protein for the fingerling and production diets of the above species. Higher values reported for the channel catfish may be attributed to the fact that the fish, being carnivore, requires higher amount of energy per unit weight of protein.

In growing animals, part of the retained energy is stored as protein and part as fat. Besides water temperature and maturity stages, deposition of these energy resources depends upon the amount by which the dietary energy intake exceeds the energy expanded as heat. In almost all cases retention of energy and deposition of new tissue result in an increase in weight of the animal. High energy diets, especially when a higher percentage of the calories is from fat, will produce fatty fish which have a lower dressing percentage than fish fed a low energy diets. In the present study the diet containing minimum carbohydrate and maximum amount of fat as well as highest energy (3870 cal/g) was found to produce fatty (32% dry weight) carcass. Enhanced lipid deposition noted in *L. rohita* with increased energy intake was in agreement with observations on other fish species (Cowey and Sargent, 1979; Watanabe, 1982; Jobling and Wandsvik, 1983; Machiels and Henken, 1985; Daniels and Robinson, 1986; and Barrows *et al.*, 1988). However, additional feed energy was not reported to increase the fat content of the dry carcass in brook trout (Ringrose, 1971). The observed negative relationship between fat and water content of the body of *L. rohita* was similar to the findings on several other fish species (Cowey, *et al.*, 1972; Austreng and Refstie, 1979; Reinitz and Hitzel, 1980; and Watanabe, 1982).

Decreased PER and FCR noted during the present study with higher dietary energy was also seen in juvenile red drum (Daniels and Robinson, 1986).

SUMMARY

The effect of different energy levels on the growth and conversion efficiencies, leading to optimization of energy: protein ratio, has been reported in the fingerlings of the Indian major carp, *L. rohita*.

The best growth, food conversion and protein efficiency were noted with diet containing 3500 cal/g of energy, corresponding to 83.3 kcal/mg protein. Intake of dietary calorie below and above the aforesaid level resulted in poor growth. Moisture and fat constituents of carcass were also found to be influenced by varying calorie intake. Maximum fat deposition was observed in fish fed diet containing the highest (3870 cal/g) energy. The study indicates that, for practical diet formulation for this species, incorporation of 3500 cal/g of energy is desirable for optimum fish production.

Table I Ingredient composition of the test diets used for the estimation of energy requirement

Ingredients g/100g diet	Dietary protein level		
	45%	42%	45%
Casein	40.17	38.00	40.17
Gelatin	12.84	12.00	12.84
Dextrin	28.00	28.00	18.99
α-cellulose	7.99	8.00	8.00
Corn oil	4.00	6.00	10.00
Cod liver oil	2.00	3.00	5.00
Mineral mix	4.00	4.00	4.00
Vitamin mix	1.00	1.00	1.00
Water	100.00	100.00	100.00
Gross energy (kcal/100g dry diet)*	338.00	350.00	387.00
Protein : energy ratio (kcal/mg protein)	75.00	83.30	86.00

*Calculated on the basis of physiological fuel value, 4.5, 8.5 and 3.0 kcal/g of protein, fat and carbohydrate, respectively.

Table II Mineral premix

	g/100g
Calcium biphosphate	13.48
Calcium lactate	32.40
Ferric citrate	2.97
Magnesium sulphate	13.70
Potassium phosphate (dibasic)	23.86
Sodium biphosphate	8.72
Sodium chloride	4.35
Aluminium chloride 6 H_2O	0.015
Potassium iodide	0.015
Cuprous chloride	0.010
Manganous sulphate H_2O	0.080
Cobalt chloride 6 H_2O	0.100
Zinc sulphate 7 H_2O	0.300

Table III Vitamin premix

	g/100 g
α-cellulose	8.0
Choline chloride	0.500
Inositol	0.200
Ascorbic acid	0.100
Niacin	0.075
Calcium pantothenate	0.050
Riboflavin	0.020
Manadione	0.004
Pyridoxine Hcl	0.005
Thiamin Hcl	0.005
Folic acid	0.0015
Biotin	0.0005
α-tocopherol acetate	0.040
Vitamin B_{12} (10 mg/500 ml H_2O)	0.5 ml

Table IV Results of feeding purified test diets to *Labeo rohita* during a 6-week feeding trial

	DIETARY ENERGY LEVEL (kcal/100g, dry diet)		
	338.00	350.00	387.00
Initial individual weight (g)	1.10	0.98	1.01
Final individual weight (g)	1.93	1.85	1.74
Percentage increase in weight	74.93	89.08	71.72
Specific growth rate(%)	1.33	1.52	1.28
Food conversion ratio*	2.63	2.06	2.56
Protein efficiency ratio	0.85	1.15	0.86
Gross growth efficiency	0.38	0.48	0.39
Percentage survival	100	100	100
Carcass Composition			
Moisture (%)	70.75	70.29	68.18
Fat (% dry wt. basis)	25.43	28.29	32.15

* Dry to wet basis

Results are mean of duplicate runs

Fig. I : Weekly changes in average fish weight (g) at varying energy levels (●——● 338 kcal; o——o 350 kcal; ▲——▲ 387 kcal).

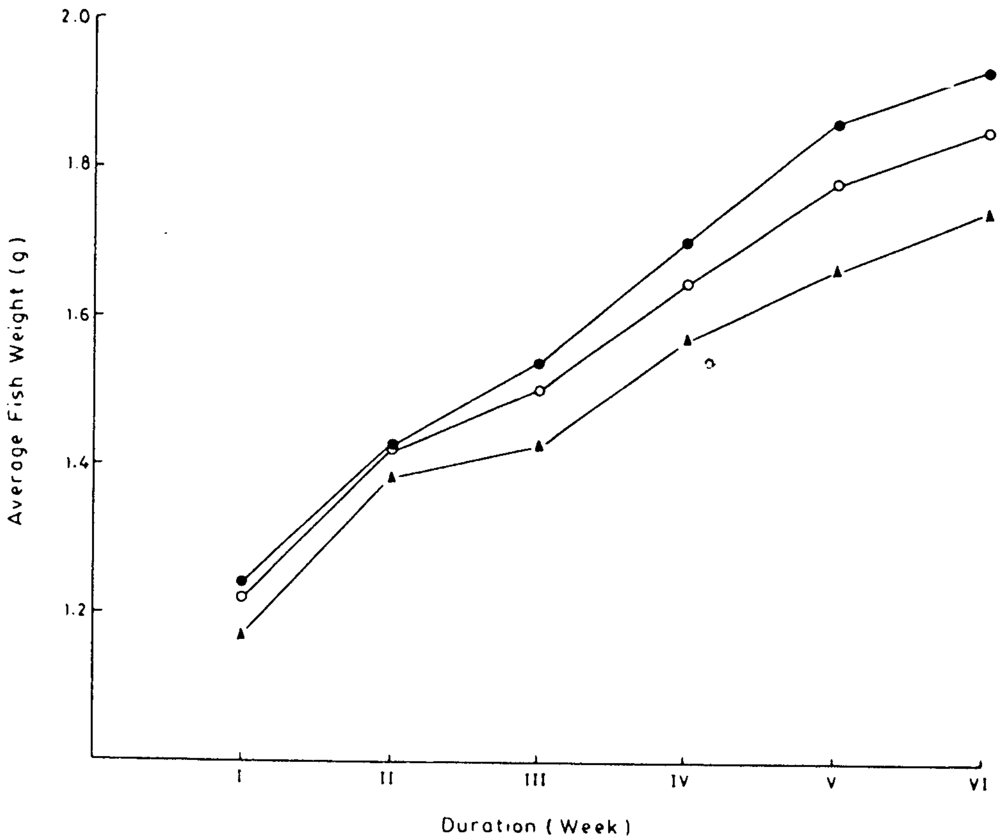

2.0
1.8
1.6
1.4
1.2
Average Fish Weight (g)
I
II
III
IV
V
VI
Duration (Week)

Fig. II : Growth of *L. rohita* on various dietary energy levels (●——● 350 kcal; o——o 387 kcal; ▲——▲ 338 kacal).

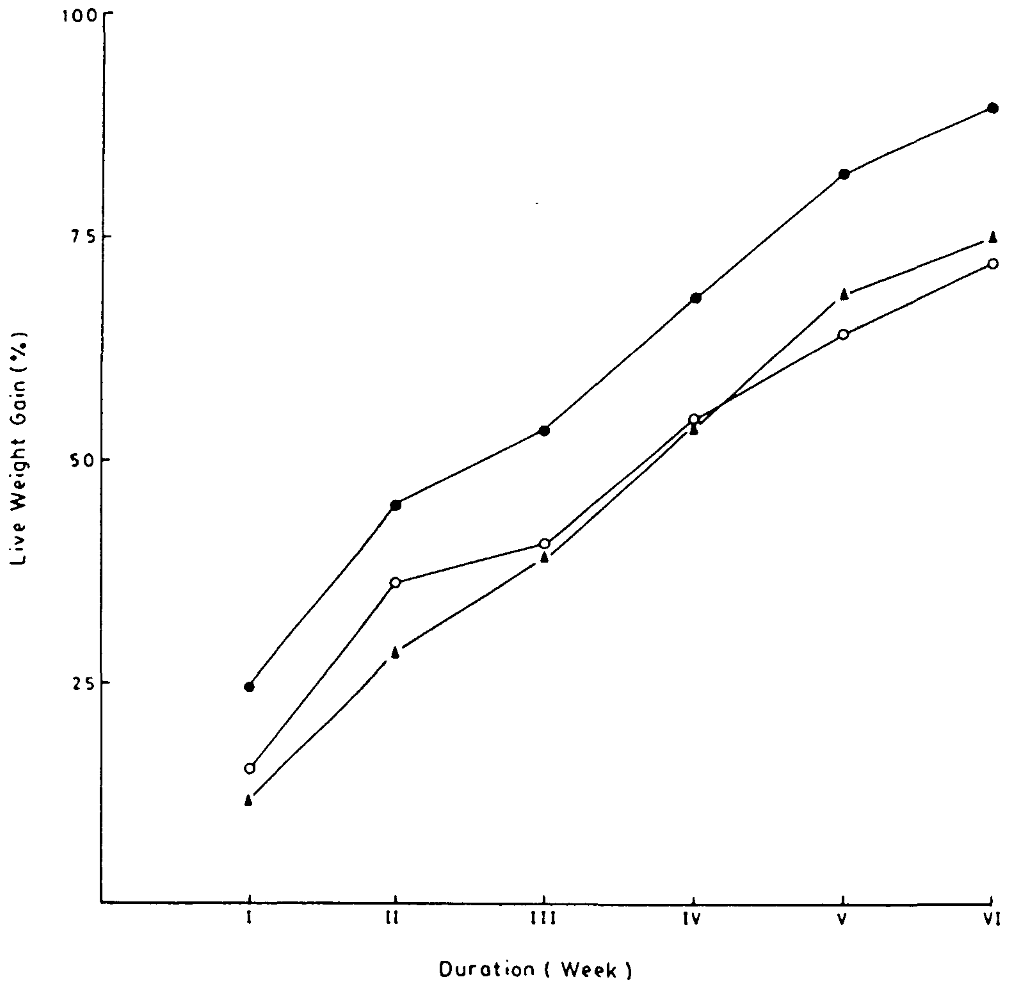

100
75
50
25
Live Weight Gain (%)
I
II
III
IV
V
VI
Duration (Week)

Fig. III : Specific growth rate (%) of _L. rohita_ fed varying energy levels.

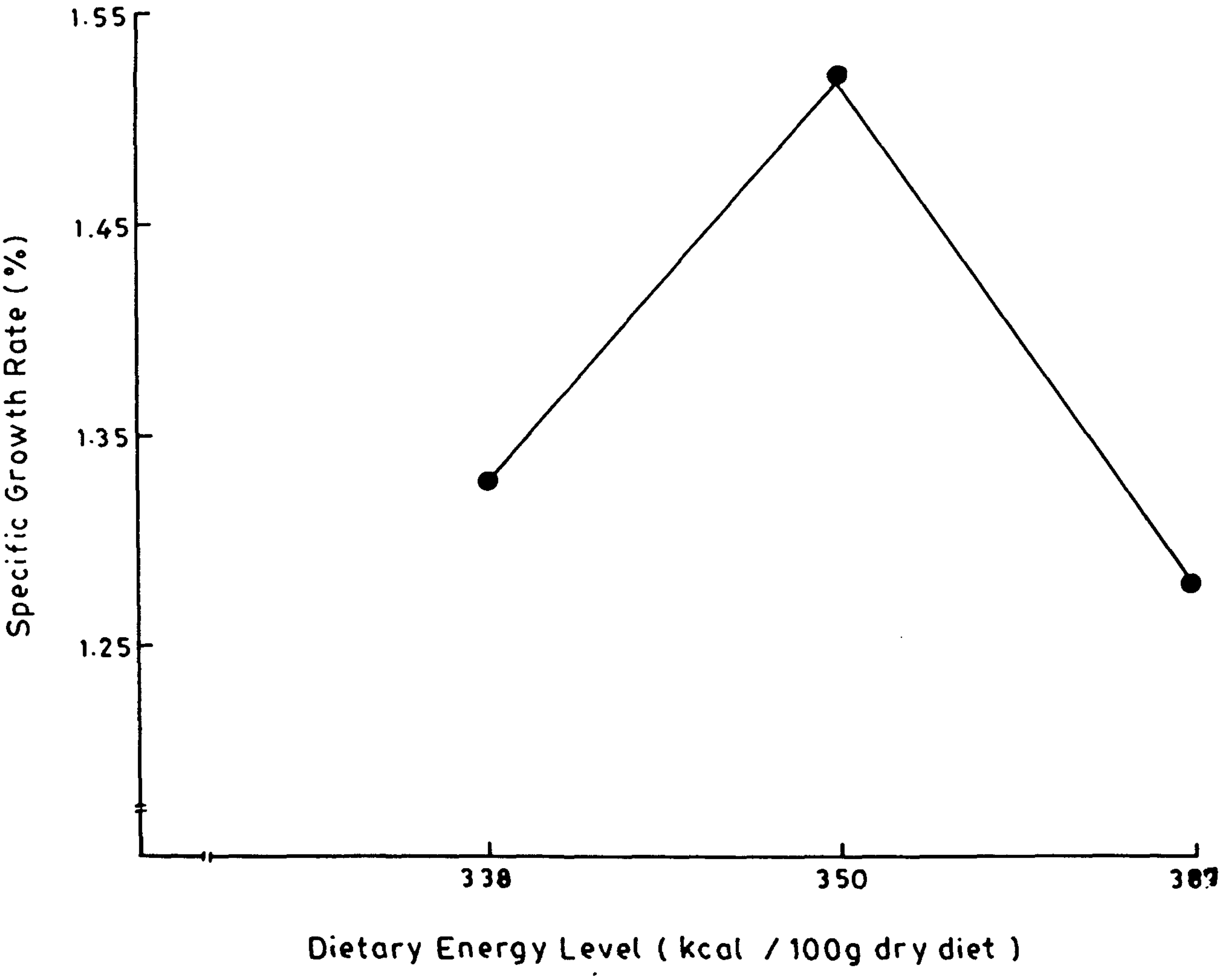
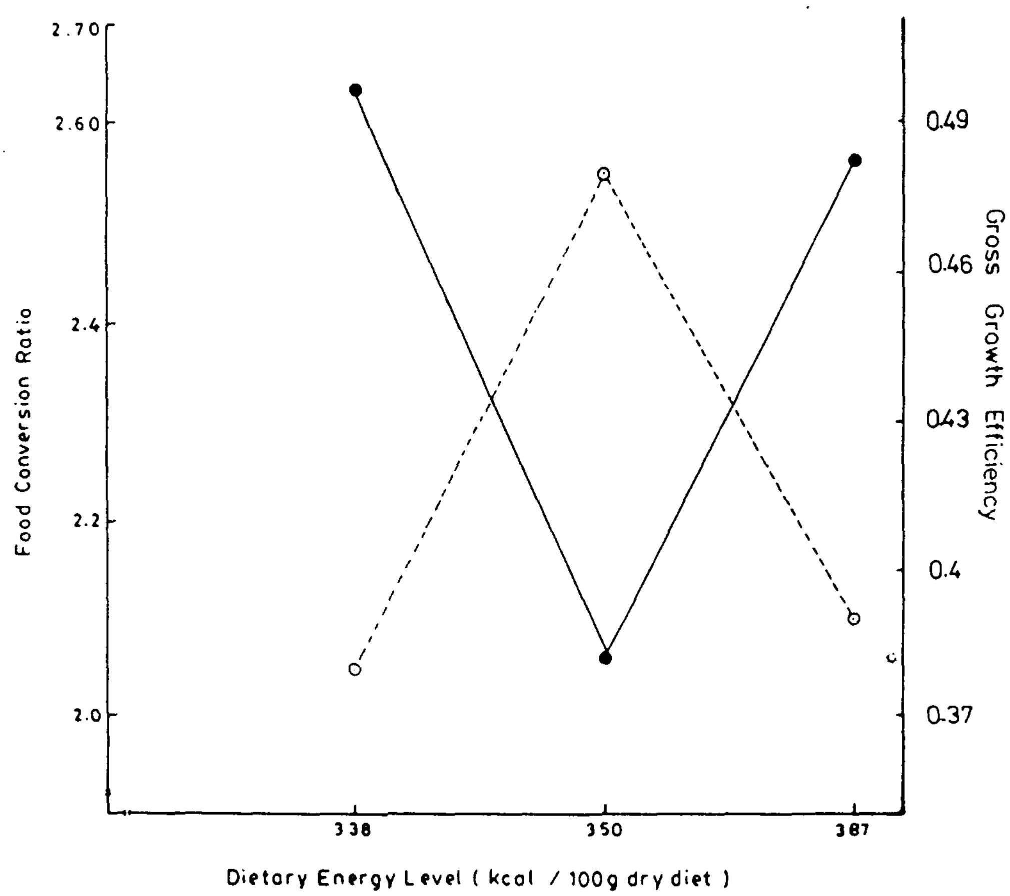

1.55
1.45
1.35
1.25
Specific Growth Rate (%)
338
350
387
Dietary Energy Level (kcal / 100g dry diet)

Fig. IV : Food conversion ratio (●———●) and gross growth efficiency (O------O) of *L. rohita* fed varying energy levels.



2.70
2.60
2.4
2.2
2.0
Food Conversion Ratio
0.49
0.46
0.43
0.4
0.37
Gross Growth Efficiency
338
350
387
Dietary Energy Level (kcal / 100g dry diet)

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